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The Photoscopic Language Translator
Conceptual Aids in Developing Data Processing Systems
Fire Control Computers — Their Development

AUGUST
1960

VOL. 9 - NO. 8 & 8B

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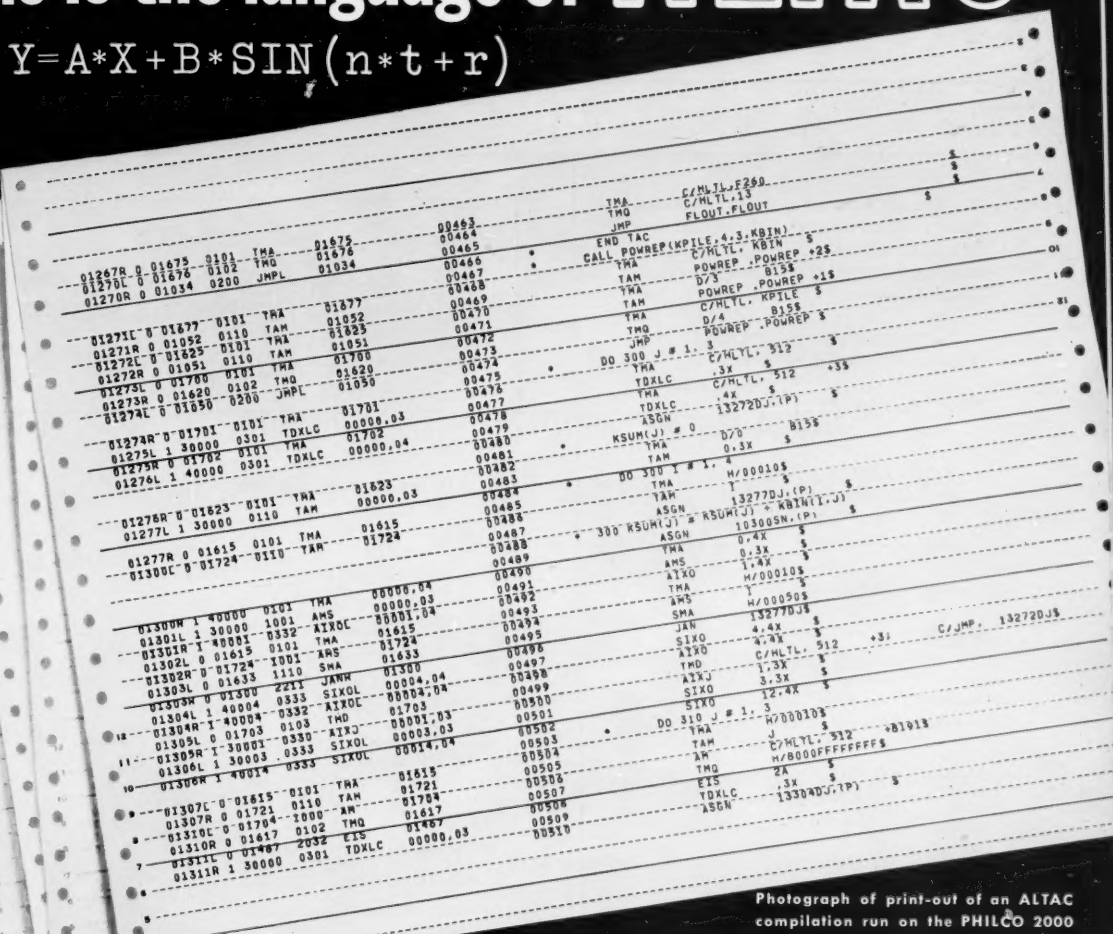
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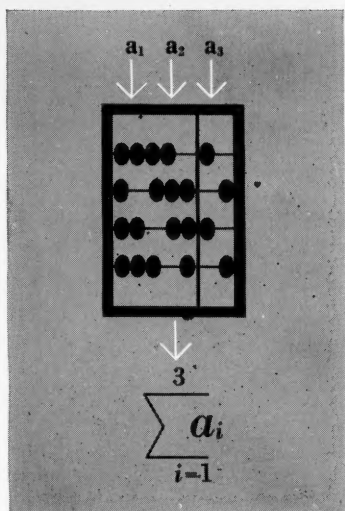
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THE PHOTOSCOPIC LANGUAGE TRANSLATOR

Neil Macdonald

Assistant Editor, Computers and Automation

I. General

In May, at the Mohansic Research Laboratory in Yorktown Heights, N.Y., the International Business Machines Corporation in cooperation with the U.S. Air Force, demonstrated publicly for the first time a machine that has been translating the Russian newspaper, *Pravda*, into rough but meaningful English since June 1959.

The Russian translation program at the laboratory has been carried out mostly under contract to the Air Force's Air Research and Development Command, but is also being supported by IBM. A Russian dictionary of some 55,000 word stems has been compiled so far. With the word endings also listed, this corresponds to about a half million words as they appear in text. Ultimately, the Russian dictionary may contain 400,000 stems.

The machine is capable of translating at the rate of 30 words a second. Currently, however, translation is restricted by the speed of the punched paper tape input and the electric typewriter output. The punched paper tape input is produced currently by a typist who types the Russian characters of the text copying them; the machine she is typing on produces in paper tape the binary punched code for each character.

The heart of the electronic translating system, however, is the rotating glass disc called the "photoscopic disc memory," shown on the front cover of this issue of **Computers and Automation**. About 300,000 coded words are arranged in about 700 concentric tracks, each formed of a sequence of black and white squares, .00033 inches on a side. These are the binary coded forms for the Russian characters and punctuation marks. A sharply focused light beam quickly scans over these tracks, chooses the right track, and matches the Russian input word to the Russian dictionary word on that track. The disc rotates about 23 times a second. The matching is done in less than 1/20 of a second. Corresponding English words are then printed out immediately by an electric typewriter. If at any time the machine finds a word not in its vocabulary, it prints this word in red for later addition to the disc memory. It also prints in red any proper names or nouns which must be "transliterated" or changed from the Russian alphabet to ours.

Next Stages

IBM is also pursuing its own research in automatic reading of printed matter and is supporting a development

program at the Baird-Atomic Corporation, Cambridge, Mass. By the end of this year, it is expected that electronic equipment will automatically read and recognize printed material and feed it to the computer at a rate of 40 words a second.

The grammatical capacity of the electronic translator is still well below college level, but a lexical buffer and sophisticated word analyzer now under development will improve this by next year.

The analyzer contains specially-designed logic circuits for analysis of sentence structure and is expected to provide smoother translation from Russian to English than is possible with the present machine.

A new, solid-state, transistorized version of the language translator, the Mark II, is being manufactured at the IBM Federal Systems Division plant in Kingston, New York. This will be faster, extremely reliable, and much more compact than the Mark I model now operating. It is believed that this machine alone will handle all of the U.S. government's presently known translation needs.

Background

Today, less than one percent of the world's foreign technical literature is being translated into English. Only a small portion of this gets to those who need it.

In the Soviet Union, over 2,600 full-time people at the All-Union Institute for Scientific and Technical Translation, plus 26,000 part-time scientist translators publish yearly one-half million abstracts of translated books and articles. The advantage of this in terms of scientific and technical progress has been demonstrated repeatedly. The United States is unlikely to catch up using conventional translation methods. It is for this reason that IBM and the Air Force have felt the need for automatic language translation.

While the Air Force's main interest in machine translation is in the area of Russian technical information, it is of course true that other areas in industry, science and government already desperately need new ways of storing and retrieving the constantly changing and increasing masses of information. Automatic language translation is one of the first steps in organizing, finding, and disseminating the latest information in fields as diverse as cancer research, physics, chemistry, economics, and space technology. Russia alone publishes several billion words a year in such areas

Less than one tenth of one percent is currently translated — at a present cost of about eight to ten cents a word to the United States Government. The electronic translator can cut costs to a very small fraction of this. But even more important are the many important Russian papers which could be translated, but which are now left untouched due to lack of time and money.

Early work done by Dr. Gilbert W. King in this field was carried out at the International Telemeter Corporation. In addition, the Air Force contractors have included Cambridge University (England), Harvard University, University of Indiana, University of Milan (Italy), New York University, Syracuse University and the University of Washington, as well as Baird-Atomic Corporation, Intelligent Machines Research Corp. (now part of Farrington Mfg. Co.), Thompson Ramo-Wooldridge, and International Business Machines Corporation.

Machine Translation from French to English

At the same time, IBM also reported progress in a program of machine translation of French undertaken by the company on its own. In this program, a dictionary of about 23,000 French words and their English equivalents is already being used to produce rough translations of mathematical papers. This machine translator's vocabulary will be increased shortly to permit translation of non-mathematical subjects as well.

The present quality of the machine translation, which is similar to the present quality of the machine translation from Russian to English, is indicated in the following example, which consists of A, a passage in French, and B, the translation in English.

A

DEFINITION DE LA LOGIQUE MATHÉMATIQUE. La logique algébrique qui est le sujet de ce cours, est conçue ici comme la partie la plus élémentaire de la logique mathématique. Plus tard nous préciserons ce que nous entendons signifier par le mot "algébrique." Mais il faut indiquer tout de suite en quoi consiste la logique mathématique dont la logique algébrique constitue la première partie.

Dans cette intention rappelons que le mot "logique" a trois sens différents dans presque toutes les langues.

B

DEFINITION (OF) THE MATHEMATICAL LOGIC

The algebraic logic which is the subject of this course/s is conceived here as the part the most elementary (of) the mathematical logic. Later we/us will specify what we/us hear/mean signify by the word "algebraic." But one needs indicate immediately in what consists the mathematical logic whose algebraic logic constitutes the first part.

In this intention recall that the word "logic" has three different sense/s in almost all the languages.

II. Some Technical Details

The photoscopic disc, which acts as an automatic dictionary, is read by means of a cathode-ray tube light source, a moving lens, a photo multiplier tube, and some electronic circuitry (the digit detector). In addition to the disc equipment, key portions of the system include the input Flexowriter, which is used for typing the input Russian text, the

input register which holds input text until the disc is searched for the proper dictionary entry, and the output Flexowriter which prints the translation.

Input

The input Russian characters are each coded in the form of holes in an input tape. After the tape passes through the tape reader, the information becomes coded into "ones" and "zeros," six per character, and is placed in the input register.

Comparison

These characters are then compared with the information being read out of the dictionary in order to determine the proper direction to move the lens and cathode-ray tube beam. The light beam continues to step across tracks, reading a small portion of each, until the comparator indicates that it has gone too far. The light beam is then brought to rest and the disc rotation (23 r.p.s.) allows the reading of every entry on a particular track. This corresponds approximately with our reading the entries on a page of a printed dictionary from the bottom up in order to get the longest possible match (for example, "time constant" before "time"). When a proper match to a Russian semantic unit has been found, the corresponding English meaning is read out through the high-speed register to the output Flexowriter. At the same time, logical circuitry indicated by the "distributor" has kept an account of the number of input characters for which a match has been found. This allows the input characters which have just been translated to be discarded and fresh input characters to be shifted into the input register.

Output

An output buffer is the gathering place for all output characters prior to printing out. It holds one character at a time, receiving it from various sources depending upon the nature of the contents. When no translation whatsoever is required, such as for Roman characters, punctuation, and numerals, the characters come directly from the input register. In the case of Russian word inputs, English meanings come to the output buffer from the disc memory equipment. In the case of input Russian which must be transliterated into Roman characters, such as proper names, the direct transfer from the input register is blocked so that control circuits can allow the transliteration stuffing equipment to make the proper changes. When an input Russian word should be translated but cannot be found in the automatic dictionary, it is also transliterated. In both cases of transliteration, the output typewriter ribbon color is shifted to red. This feature allows the user to notice at a glance what additions are required in the next edition of the dictionary.

Light Source

A cathode-ray tube is used as a light source because an electron beam can be moved faster than any other source. When it is necessary to move the light from one disc track to another, the change is made extremely rapidly by means of the deflection current. The lens motor, with its higher inertia, moves more slowly and allows the cathode-ray tube electron beam to return to the center of the tube face. Thus the cathode-ray tube beam makes possible the low access time (35 milliseconds average) while the lens motor prevents the electron beam from going too far toward the side of the tube.

Speed

The speed of this translating system is sufficient to translate Russian technical literature at an average rate approximately equal to the rate at which it is produced (30 words per second at present), except that the relatively slow speed of the input and output Flexowriters restricts the speed of the system to a substantially lower rate. In the future it is expected that the input speed limitation will be removed by the use of automatic page scanners and character sensing. The output speed limitation can be eliminated by means of high speed printers and by multiplexing several output units.

Memory

The ten-inch glass disc contains 30 million bits of information on 700 tracks in an annulus 0.36 inches wide. The width of the annulus is kept as small as possible for the sake of rapid access. The coded lexicon entries are represented by clear and black squares approximately one-third of a mil (0.00033 inches) on a side. These marks interrupt the light beam from the cathode-ray tube on its path to the photomultiplier and, therefore, differentiate a zero from a one. Since these marks have been kept small for the sake of access time, the light source on the face of the cathode-ray tube has also been kept small. It is, however, quite intense (1600 candle power). In order to prevent the electron beam from burning the phosphor on the face of the tube, as will happen in any cathode-ray tube when its beam is kept in the neighborhood of a single spot, the beam, in addition to the motion required for stepping from track to track, is made to trace a circle about two inches in diameter. This motion is compensated by a vibration in the lens so that positioning on the tracks of the disc is not affected.

Addresses

Lexicon entries on the disc are laid out in such a way that the Russian words and idioms themselves make up the address of the entry. Each character in the Russian word has a certain binary code which can be interpreted as a weight. Cyrillic "e" has the lowest weight and Cyrillic "B" the highest. Each coded Russian word, therefore, looks like a long binary number. The layout on the disc is in numerical order, which is different from alphabetical order but has a kind of similarity to alphabetical order. When the disc is being scanned track by track, each bit (one or zero) in the Russian word is compared with the corresponding bit in the input register (which here is acting like a memory address register).

This comparison is continued until disagreement is found. At this time, a "zero" on the disc and a "one" in the input register means "go ahead" to the next track. The inverse combination means "go back." Only when the correct entry has been passed is a particular track scanned exhaustively at a rate of one million bits per second. The exact match has been found when each one and each zero in the Russian dictionary word matches up exactly with each one and zero in the input register until the symbol signifying the end of the Russian word in the dictionary entry is reached.

The search electronics could readily be reduced in size by converting the high speed vacuum tube circuits to transistor circuits.

The design of the dictionary has utilized photographic techniques because photographic emulsions are the densest storage media known today. Although this storage is permanent, a great deal of work has gone into the design of equipment which can prepare new discs rapidly, thus allowing frequent updating of the list of entries in the dictionary.

Preparation of the Memorized Dictionary

The system for preparation of the disc memory begins with a document which contains entries to be placed in the dictionary. These entries are keypunched into cards. Once the cards have been prepared, an IBM 704 computer merges new cards with old by straightforward sorting procedures, placing the complete list of entries on magnetic tape. The 704 sorting program also will place any random mixture of dictionary entries into proper numerical order. Especially designed equipment allows the magnetic tape to serve as input to a film-making machine which photographically codes entries on rolls of 70-mm film. The use of film as a preliminary step prior to making the disc substantially reduced the initial engineering problems (such as timing) and allowed faster progress in building a working system.

Since film-making is a photographic process (a cathode ray tube light source is turned on and off in accordance with coded binary information arriving from the magnetic tape while the film is passed through the machine), photographic processing must follow the exposure. Although a standard Air Force photographic processor is used at present, some improvement appears desirable for future systems. Toward this end, research is developing a special film processor which makes the processing automatic.

Information on the film is recorded on the disc by means of a Disc-Making Unit. Here again a cathode-ray tube light source is used, along with a mirror and lens system for passing light through the film to the emulsion on the disc. A servo system is utilized for accurate focussing. The disc is turned at one revolution per minute during exposure. Special precautions have been taken in the design to keep the speed and timing within close tolerances. The size of the photographic spots of information is reduced by a factor of about 55 during this process.

The photographic processing of the disc after the disc-making machine records the information is extremely sensitive to foreign particles in the developing and fixing fluids due to the extremely small size of the information bits (0.00033 inches square). Commercially available solutions are completely useless until they are finely filtered. To overcome this problem, a special disc processor was designed. This device minimizes the quantity of fluid used and then filters immediately before the fluid touches the emulsion surface.

As a result of the great care taken in the design of the disc-loading system, new dictionaries can be prepared on approximately a daily basis if desired. This speed meets the requirements of language translation by a wide margin. However, even if more rapid updating of the storage is required, a small erasable store such as a drum could easily be added. In this system, the input address would initiate simultaneous searches in the large capacity photostore and in the small capacity erasable store. In most cases information would be found in the photostore only. Whenever a match would be found in both memories, the "logical choice" equipment would dictate that the erasable store be read out, since its information would be the most recent.

NEWS of Computers and Data Processors

"ACROSS THE EDITOR'S DESK"

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THE PB 250 GENERAL PURPOSE DIGITAL COMPUTER

Max Palevsky, Vice President
Packard Bell Computer Corporation
1905 Armacost Ave.
Los Angeles 25, Calif.

Over the past five years general purpose digital computers have developed in size, speed, and flexibility, but this development has been mainly concentrated in the field of large-scale computers, while medium and small computers have shown little change. A glance at a comparative chart of these latter computers shows that, aside from the appearance of transistorized machines, no significant change has occurred except, perhaps, that more recent computers are more costly. The result is a comparative de-emphasis on small and medium-sized computers, with a growing tendency to large-scale centralized computing. Two things are required if this trend is to be reversed: (1) less expensive small computers, and (2) computers which can better compete on cost-per-unit-answer with large-scale machines.

Speed

The PB 250, which was introduced by Packard Bell Computer Corporation at the Western Joint Computer Conference in May, is the first computer with both of these characteristics. Costing only \$30,000, it can compete with large-scale machines in speed and flexibility. Up to 40,000 operations can be performed each second. Add time is 12 micro-seconds, multiply requires 276 micro-seconds, while divide and square root each takes 252 microseconds. Further, the last

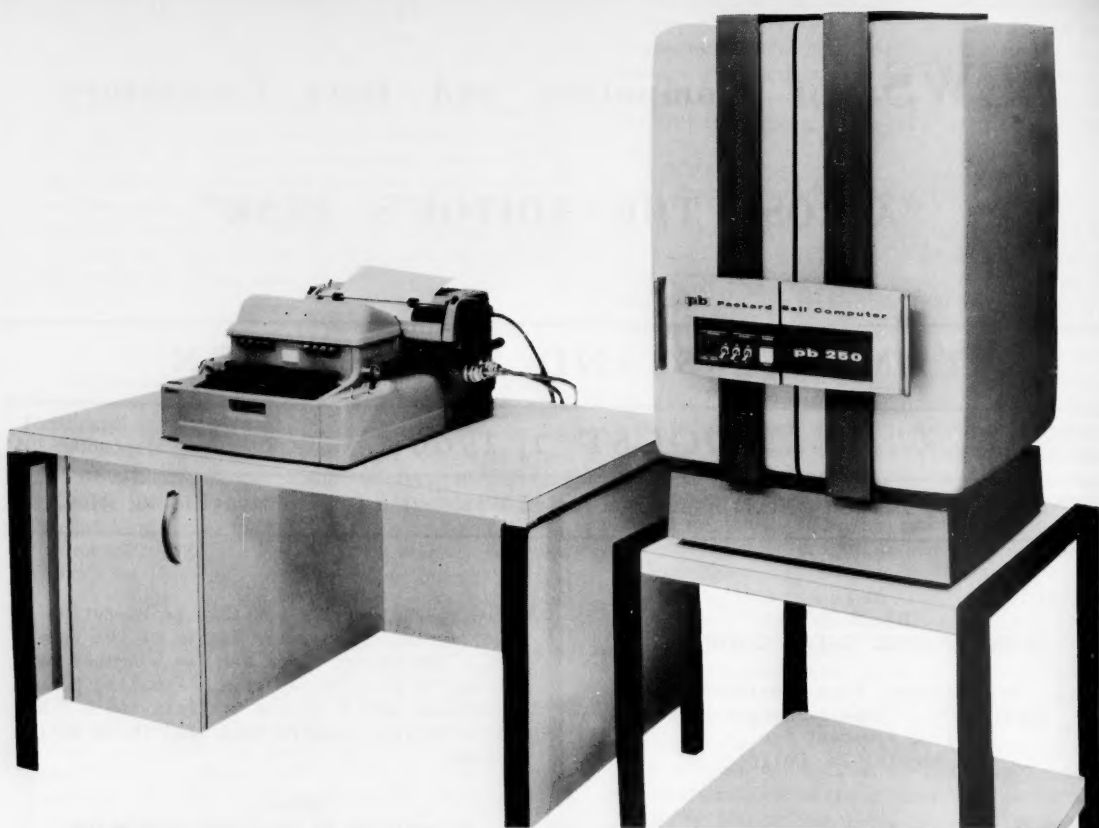
three operations are variable in execution time, depending upon the length of the numbers. The quoted times are for a number consisting of 21 bits and sign. Floating point operations with a 37-bit mantissa and a 7-bit characteristic require less than three milliseconds.

Commands

In addition to the speed with which arithmetic operations can be performed, the PB 250 overall speed is also a function of a rich command structure. The 46 commands include block transfer, Gray to binary conversion, and control over an elaborate input/output system. Programming is simple, with single address instructions, command indexing, and automatic double-precision operations. Cost-per-unit-answer depends upon programming ease as well as computing speed. The PB 250 is provided with a symbolic programming system employing mnemonic instruction codes and a variety of subroutines.

Memory

Both the data and the commands required for computation are stored in a homogeneous memory. The storage medium -- of 1808 words in the basic computer -- is a group of nickel-steel magnetostrictive delay lines along which acoustical pulses are propagated. At one end of each of these lines is a writing device for translating electrical energy into acoustical energy. At the other end of each line is a reading device for translating acoustical energy back into electrical signals. By re-writing the stored information as it is read, information continuously circulates without alteration except for alterations which result from the execution of the computer program.

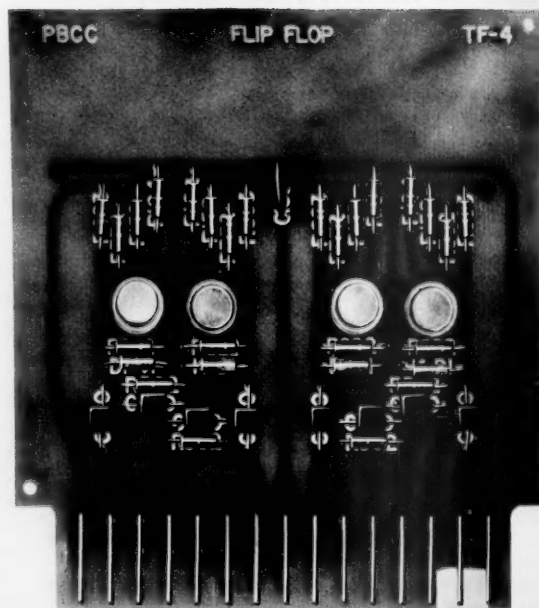


An additional cost factor that often has made small computers impractical is that of expanding the memory. The magnetostrictive delay lines, together with their associated circuitry, are mounted on plug-in etched modules. The memory can be inexpensively expanded to 16,000 words by the addition of similar modules, and, further, these can be fast-access as well as bulk-storage lines. 16,000 words of core storage also can be added externally, with an in/out rate of up to 85,000 words a second. All memory operations are parity checked.

Input/Output

Both input and output information can be processed while computation proceeds. Standard input includes an alphanumeric typewriter, a paper-tape punch and reader, high-speed (2 megacycle) block input and output, 32 control outputs and 30 control inputs. The latter may control a wide range of peripheral equipment and other devices. High-speed paper tape equipment and up to six magnetic tape handlers are optional equipment. The magnetic tapes can use any code up to eight channels.

The PB 250 can operate in tandem with another computer as an input/output proces-



Basic module of the PB 250 computer

sor. When this other computer is another PB 250, the two computers operate as a single synchronous system. This separation of input/output processing from central computing results in a very powerful system, one that up to now has been available only in very large and expensive computing systems. Further, the two PB 250's can be employed separately when input/output requirements are not excessive.

Punched card equipment will be available in the near future. Standard Multiversers of this company are available as analog-to-digital and digital-to-analog converters.

Conversion

The speed and flexibility of the PB 250's input/output system permits it to function as a universal format-to-format converter. The cost of such converters has been high up to now, even without complete universality. The PB 250, because it is a general purpose computer, can perform any transformation between formats and media and perform a variety of editing and arithmetical operations in the process.

Maintenance

The final cost to be considered in the operation of a computer is in maintenance. The PB 250 is completely solid state and uses only 350 transistors. Furthermore, it is the first commercial computer to be completely modularized. The basic module is shown in the figure. All circuits are of this type. 145 such cards, together with a plug-in magnetically-regulated power supply and a Flexowriter, make up the entire computer. The size of the computer is 30" x 19" x 24". Low density packaging has been used to assure a long life and high reliability; approximately 25% of the module spaces are not employed in the basic computer. The computer proper requires 30 watts and 2 voltages. A rack-mounted version of the PB 250, using 31 - 1/2" of a standard 19" relay rack, permits easy integration of the computer into a wide variety of on-line and off-line computing systems.

COMPUTER APPLICATION TO STEEL FORM CONSTRUCTION CO.

Royal McBee Corp.
Westchester Ave.
Port Chester, N.Y.

Economy Forms Corp., Des Moines, Iowa, is a growing business, with increased sales and increased paperwork. The company manufactures, sells, and rents steel forms for concrete construction. With many different

products and sizes, with a complex incentive payroll program, and with 350 employees, two different manufacturing plants, and eight district offices and warehouses, there was a considerable volume of paper work.

Approximately one year ago, the company's management decided to install an integrated electronic data processing system to handle incentive payroll, sales analysis, and finished goods inventory record-keeping. This is the initial phase of a comprehensive program designed to simplify and expedite paperwork in a majority of the firm's departments. The program uses a desk-sized computer, the LGP-30. Plans now are underway to adapt the computer to handle accounting procedures for rental equipment (the company does a large business in rentals), warehouse shipment programming, production control.

The computer has proved to be useful and efficient.

U.S. NAVY EMPLOYS COMPUTER TO CONTROL CLASSIFIED PUBLICATIONS

Remington Rand
315 Park Ave. South
New York 10, N.Y.

The Registered Publication System (RPS) Department of the U.S. Naval Security Station in Washington, D.C., has transferred control of its vast store of vital military publications to an electronic computer system.

The RPS, which operates through a network of 13 issuing offices ranging from Pearl Harbor to London, is responsible for the distribution and accounting of approximately 4 million publications yearly to 2,600 Naval commands ashore and afloat. This large inventory of widely dispersed registered publications was far exceeding the capabilities of any manual accounting system.

The newly installed Remington Rand Univac Solid State Type 80 Magnetic Tape System will maintain master files listing publications held by each command. The system locates items by a rapid search of its memory drum or file of magnetic tapes. The tape input-output devices transfer data at the rate of 25,000 alphabetic or numeric characters per second. The high-speed printer reports the results of searches at the rate of 10 lines per second.

MAGNETIC TAPE RECORDER FROM NOSE CONE THAT REENTERED ATMOSPHERE

Ampex Data Products Co.
934 Charter St.
Redwood City, Calif.

On June 13, 1958, a Thor-Able U.S. Air Force rocket was launched from Cape Canaveral, Fla., containing a "Datasphere", an instrumented capsule including a magnetic tape recorder, which had the job of reporting data unavailable by telemetering, to be gathered during re-entry into the earth's atmosphere.

In a glass case in the rotunda of the Smithsonian Institution in Washington, there now rests a large black ball and beside it, a battered, acid-corroded tape recorder. The ball is the "Datasphere". This was the first instrumented capsule launched by an Air Force ballistic missile to be recovered intact from the sea. The tape recorder, which went along inside the capsule to record data which could not be telemetered to ground stations during re-entry, is an Ampex MR-100.

Developed by the General Electric Company's Missile and Space Vehicle Department, the Datasphere began its journey to the upper Ionosphere as a passenger in the nose-cone of the rocket.

The Datasphere was ejected from the nose-cone when the cone was re-entering the Earth's atmosphere at 10,000 miles per hour. The Datasphere continued, without restraint, until it struck the Atlantic Ocean with an impact deceleration of 40,000 g's. Nine days later it was fished from the South Atlantic Ocean. The data recovered from the tape, data unavailable from previous flights due to characteristic failure of telemetry during certain phases of re-entry, were exceedingly valuable to the missile's designers.

NEW ELLIOTT 503 COMPUTER SWITCHES IN 5 MILLI-MICROSECONDS

John Geddes
Elliott-Automation, Ltd.
34 Portland Place
London W. 1, England

The new digital computer, Elliott 503, incorporates the new ultra-high-speed switching techniques recently announced by this company.

With a switching time of only 5 milli-microseconds, the 503 is, by the best of present day standards, one of the fastest compu-

ters to be marketed anywhere. The high switching speed gives the new computer a working capacity incomparably greater than that of conventional types of computers.

The 503 retains the simple, easily understood instructions developed for earlier types of Elliott computers. The complete computer system for the 503 will incorporate an unlimited extension of the storage facilities by means of new high-speed magnetic-tape storage units as well as a wide range of input and output equipment and special keyboards for the running of parallel programs. The capacity of the new computer is such that, by time-sharing, it will be possible for computers of this type to undertake a number of different jobs simultaneously.

A full range of automatic programming routines, including internationally agreed autocoding systems, will be available for the new computer. They are fully compatible with those now available for other types of computers of this company.

With the enormous work capacity which results from the ultra high speed of operation of the machine, the unit cost of work done will be a fraction of that incurred on other machines of comparable size both in England and in the United States.

The company considers that the first applications for a machine of this speed and work capacity are likely to be for scientific work in research establishments, universities and technical colleges.

JAPAN AIR LINES ORDERS BENDIX G-15 DATA PROCESSING SYSTEM FOR USE IN FLIGHT PLANNING

Bendix Computer Div., Bendix Corp.
5630 Arbor Vitae St.
Los Angeles 45, Calif.

A precision-minded weather forecaster has been "hired" by Japan Air Lines to boost efficiency in their aircraft operations.

The forecaster -- a Bendix G-15 data processing system -- will soon be installed for use by the air lines' Meteorological Division to keep track of up-to-the-minute weather and operations data. The computer's chief job will be that of figuring optimum flight plans quickly and accurately by making the most advantageous use of speed, time, wind, fuel flow, temperature, load, and cost information.

The G-15 is presently doing similar work for United Air Lines and American Airlines.

COMPUTERS and AUTOMATION for August, 1960

BUSINESS MACHINES INDUSTRY -- INVESTMENT PROSPECTS

Value Line Investment Survey
5 East 44 St., New York 17, N.Y.

The new world of electronics and the traditional skills of office equipment making are blending together to create the products of today's business machines industry.

Sales and order backlogs in computers and related equipment are up sharply in 1960. Profit margins are wider too, now that "make-ready" costs -- tooling-up, employee training and heavy initial promotional expenses -- are tapering off. Volume is up, the better to carry continuing research and development programs.

Many problems still confront the business machine industry; and these are not only engineering. Capital requirements are mounting. Much of the newest equipment is leased rather than sold. Costs are not fully recouped for 3 to 4 years. The ultimate earnings potential from the leasing procedure is greater than from outright sales. However, the capital requirements are so enormous that all but the strongest companies are in danger of having their production limited by the length of their credit lines. The big entrenched manufacturers are likely to grow and prosper; some of the smaller manufacturers may well fall by the wayside or disappear by merger.

By the mid-Sixties, the leading modern business machine manufacturers, having established themselves in the electronics field, will probably enjoy sharply increased earnings. But investors are cautioned that most equities in this group are currently overpriced, in terms of normal values over the next 12 months, and that future earnings profits are already well discounted.

EMBOSSSED "CREDIT CARDS" FOR PROPERTY

Dashew Business Machines Inc.
3655 Lenawee Ave., Los Angeles 16, Calif.

The Supply Services Agency of the North Atlantic Treaty Organization has been faced with an enormous problem in inventory control with millions of pieces of equipment and supplies continually flowing to and stored in member nations. Keeping track of materiel is a logistic headache of the first magnitude.

Recently a decision was made to install an electronic data processing system to achieve the highest degree of proficiency in

accounting for the mountains of NATO materiel. Dashew Business Machines proposed a property identification system using embossed metal plates attached to every major and minor part of every piece of equipment used by NATO, as well as all supplies. A contract has now been signed between the SSA of NATO and this company.

Impervious to heat, moisture and rough handling, the plate provides indestructible identification on each piece of property shipped to member nations.

Because of developments in automation of data processing, the same tags can be used to record the property stock number onto punched cards which are used in inventory requisitions and other forms. The tab cards can then be fed directly into electronic data equipment, eliminating errors which often occur from manual transcriptions.

The NATO supply agency is the first military installation ever to use a system like this. Great savings in time and money are expected from the resulting tighter inventory controls.

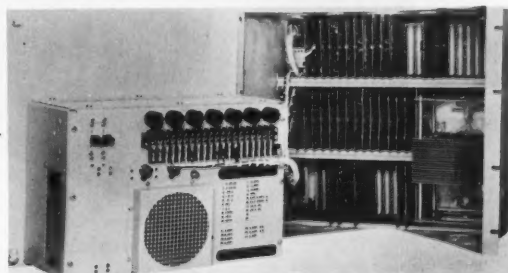
RANDOM ACCESS MEMORY

Richard Terry
Telemeter Magnetics
Culver City, Calif.

A new small general-purpose memory providing asynchronous operation at rates to 200 kc and available in capacities from 128 to 1024 words with word lengths from 4 to 24 bits is in production at this company.

The model, TM1 Type RB, has a wide range of capacities, a variety of operating modes, and low cost.

It may be operated in a random-access way, or as a sequential access buffer, or in any combination of both, without loss of speed. Applications include small digital computers, automatic control, data editing and format revision, automatic checkout programming, and automatic large-scale computer testing.



AUTOMATIC DIGITAL RECORDING AND CONTROL SYSTEM

Computer Systems Inc.
Culver Road
Monmouth Junction, N.J.

A completely transistorized, plug-in Automatic Digital Recording and Control (ADRAC) System with a capacity of 100,000 channels is being produced by Computer Systems, Inc.

It is specifically designed for monitoring and controlling up to 10 analog computers of 10,000 inputs each, but it can be used independently wherever data logging, reduction and control are required, such as in process industry operations.

When used in an analog computing facility, the system will speed up or eliminate problem set-up and check-out tasks. Without human intervention, and via punched tape, it can select a computer, place it into any one of its operating modes, set the computing elements such as potentiometers, with an accuracy of $\pm 0.01\%$, read back the voltage variables to check setting of computing elements, and then initiate problem solution.

The system can also verify the selection circuitry involved in performing its function and compare any selected voltage with a digital reference value to within an adjustable tolerance as small as $1/100$ of a volt. Out-of-tolerance variables are automatically recorded in red. The machine can automatically repeat problem runs with new voltage variable settings and new addresses in any selected computer to obtain solutions for wide ranges of parameter values. Each channel is identified by a four character address, and may carry any voltage in the range plus or minus 100 volts.



GRADUATE-LEVEL SCHOOL TO TRAIN PEOPLE TO FIND COMPUTER SYSTEM SOLUTIONS TO COMPLEX BUSINESS AND SCIENTIFIC PROBLEMS

D. R. Wright
International Business Machines Corp.
590 Madison Ave.
New York 22, N.Y.

A new institute for graduate-level training to increase greatly the new class of computer professionals is to be located on United Nations Plaza in New York City. The institute is to be known as the IBM Systems Research Institute. It will be one of the first of its kind in the computer industry.

The purpose of this graduate-level school will be to train people to find computer system solutions to the most complex business and scientific problems. The curriculum will include such subjects as case studies in systems-design, workshops in systems planning, advanced programming, and business simulation techniques. The faculty will include senior IBM systems people and visiting lecturers from industry and leading universities. The director of the Institute will be IBM vice president John C. McPherson. Annual budget for this school is expected to be about \$2 million. The first group of 30 students will be enrolled this fall. Eventually the school expects to train up to 400 people a year. Only individuals meeting high entrance requirements will be admitted. The students will be taking courses which, in many cases, have never been taught before.

Evidence of the growth of the new class of computer professionals is seen in these facts:

- A recent survey of eighteen large industrial firms shows that they employ about 1,000 special systems people. Seven years ago only five of these firms had any systems men at all.
- One utility has over 2,000 people working in data processing -- many of them in professional categories.
- Another company is freeing five of its top management people to devote their full time to thinking of new ways to utilize their computers most effectively.

The reach of computers is now being extended by "tele-processing", systems designed to gather information by wire from remote points, process and store that information in central computers, and make that information available to all points in the network on demand. It has been predicted that the day is not far off when there will be more data processing traffic over the nation's telephone wires and leased wires than there are human conversations.

COMPUTERS and AUTOMATION for August, 1960

Conceptual Aids: The Need for them in Developing Data Processing Systems

Ned Chapin

Systems Analyst
Stanford Research Inst.
Menlo Park, Calif.

What is a Conceptual Aid?

Before considering the need for conceptual aids in developing data processing systems, it is desirable to make clear what is meant here by CONCEPTUAL AID.

Consider the case of a farmer who obtains the water for a herd of livestock from a well. He notices that the well does not produce as much water as is needed during the peak water use hours. Hence, his problem is to design and build a reservoir arrangement. As a non-specialist in this area, he can bring to bear on the problem a few conceptual aids in the form of mensuration formulas for conversion of units of measure, and for volumes of variously shaped solids. By a judicious use of these aids, and data on rates of pumping and usage, on costs of equipment, etc., he can develop a reasonably economic and effective design if he desires to.

As another example, consider the case of a wholesale company that has alternative sources of supply for certain of its stock items, alternative warehouses capable of stocking various amounts of these items, and the option of supplying any customer to the extent stock levels permit from any of these warehouses. In this situation, one of the problems facing the wholesaler is how to minimize freight costs on both inbound and outbound shipments. A conceptual aid that can be used on this problem is linear programming. With this aid and under some simplifying assumptions, alternative ordering and stocking patterns characterizing the lower cost arrangements can be developed. The arrangements can recognize limits of various types, such as the capacities of the warehouses.

Stages in the Work of Development of Data Processing Systems

People who work on the development of data processing systems must deal with the usual problems involved in working in any organization. These include such matters as recognizing the limits of their area of operation, overcoming organizational inertia, getting quickly the data needed for making decisions, responding promptly to new developments, gaining acceptance of ideas, contributing to the success of the organization, etc.

But in addition these people also have more particular problems. Specifically, people engaged in the design, development, and implementation of data processing

systems in business face problems that change according to the particular stage of work concerning them at the time. Since there are about a half dozen main stages in their work, let us review the stages to highlight some of the problems.

In doing this, it is important to keep in mind that the stages blend into one another. The boundaries between them are not clear-cut, and during the course of any one day, week, month, or year, a person may work on any number of the stages. Therefore, in discussing the stages separately here, it is not implied or suggested that there is necessarily a clear or sharp distinction among them in actual practice.

1. Inspiration Stage

One of the initial stages, the origination of application ideas for data processing systems, is sometimes called the inspiration stage. This is the stage in which thought is given to what data processing systems¹ are needed, and what their character should be. Often this stage includes setting up initial guide-lines and ground rules for feasibility studies, also gathering information, analyzing it, and producing from it, by digestion and inspiration processes, ideas for data processing systems for the organization. The major problem in this stage is, therefore, getting good ideas. Since broad and inclusive concepts are generally worked with during this stage, the problem of too much detail usually does not arise.

2. Stage of Systems Analysis

A second stage of work is systems analysis. In this stage information is gathered about existing data processing systems, and about the needs which would be served by new or revised data processing systems. Generally this gathering of information proceeds in great detail, because the systems typically must be described in terms of their individual details. During this stage the sheer burden of working with these large amounts of detail is the major problem. A further problem is the significance of the individual items of detail: why are they essential or necessary for the performance of the work of this stage? From experience, it appears desirable to have a large supply of detail available, because details overlooked during this stage seem to give rise to problems in the later stages.

¹ "System" is used in this paper in the "commercial" sense, not in the "hardware" sense.

3. Systems Design Stage

The systems analysis stage commonly shades into a systems design stage. Then, the task is to devise some configuration of equipment, personnel, supplies, and operating procedures to provide the data processing service necessary to meet the organizational needs exposed during the two preceding stages. The major problem of this stage is apparently, again, the necessity of working with enormous amounts of detail because the design of the system is expressed in terms of the details of its operation. A second problem is, again, that the significance of each detail is not apparent, yet overlooking even small details can result later in relatively serious impairment of the performance of the data processing system designed.

4. Selection of Equipment

Another stage, often made a part of the preceding one, is the selection of equipment. After setting forth some of the alternative equipment configurations in the preceding stage, normally it is necessary in this stage to select by the preparation of detailed time and cost estimates one particular equipment configuration. Here the major problem is to make accurate estimates, and a second problem is to appraise accurately the capability of the equipment and personnel.

5. Programing Stage

A following stage is programing. For the equipment selected, the general patterns of the data processing are devised and set down, to describe (for the equipment and the personnel) how the processing is to be accomplished. Here the major problem is to relate the character of the equipment and the personnel capability, to the needs of the designed data processing system. A second problem is the incessant change in the designed system. A third problem is the mass of detail to be worked with.

6. Coding Stage

The coding stage which in theory follows the programing stage is the translation of the general directions produced in the programing stage into detailed step-by-step instructions to be performed by the equipment and the personnel. This is detail work, and the major problem is to cope with the innumerable details of the operation, the system, and the data to be processed. The use of automatic coding techniques has reduced some of the details, mostly, in the area of command repertoire and sequence of command use.

7. Implementation Stage

A final stage in the work of developing data processing systems is the debugging and implementation stage. This is when errors and oversights in the preceding stages are corrected, and further improvements in the system are made. The major problems of this stage typically are the training of personnel (especially on the input side) and improving of equipment reliability.

Problems

From a study of the work of people engaged in the design, development, and implementation of data pro-

cessing systems, several common elements appear. The three most significant are: (1) the large masses of details worked with; (2) the difficulty of knowing which details are important and why; and (3) the absence of any pattern or framework that is generally accepted for relating the details — the absence of conceptual aids.

1. Large Masses of Detail

The large masses of detail are a heavy burden upon people doing this work. The fact that details are worked with seems to suggest that no other acceptable alternative is available. The usual alternative in other fields is the use of data at one or more higher levels of generalization. That is, the essential features of the details in other fields can often be condensed in terms of groups or classes — aggregates based upon similar attributes of the details (working with the forest instead of the individual trees). But to work at a higher level of generalization usually requires the use of more powerful conceptual tools than are brought to bear on the details individually.

2. Significance of Details

Also, the significance of the details is a troublesome matter. Even now, after about eight years of experience in preparing data processing systems involving computers, the accumulated experience has not produced any generally accepted rules of either approach or analysis. It has not produced much even in the way of rough guides on what data is needed, how to quantify the data, or how to work with the data once gathered. It is not unusual when different well-experienced individuals produce sometimes very different "answers" to a particular computer system situation — and neither one can prove he is more right than the other.

3. Absence of Guides

The absence of any generally accepted guide for relating the details in patterns exists in the face of the availability of a large number of possible bodies of knowledge that might be drawn upon as at least in part applicable. The major bodies of knowledge that could be cited are: mathematics, accounting, operations research, information theory, organization theory, game theory, servo theory, group dynamics, automatic coding techniques, systems and procedures, etc.

But there is no theory of data processing systems as such. The bodies of knowledge mentioned have been drawn upon from time to time in the development of data processing systems, but they have generally received at most only lip service.

No Theory of Data Processing Systems Expected Soon

It is too optimistic to hope that a theory of data processing systems will be developed soon. But it does seem realistic to hope for the development of some type of conceptual aid obtained by drawing upon the accumulated near-decade of experience, and upon the bodies of knowledge available.

To gain some insight on the features such a conceptual aid might have to make it of practical value to people in the data processing field, one can study the use of conceptual aids in other fields. The results of a study of this type can only be summarized here, but a quick re-

view of a few examples of the use of conceptual aids in other fields might be helpful.

More Examples of Conceptual Aids

Take the case of a physician who has diagnosed a patient's illness. The problem then arises of selecting a course of treatment. A conceptual aid the physician can draw upon in seeking a solution to this problem is a reference manual listing drugs, citing experience with each in various conditions, and indicating the usual effects of each in various dosage levels. This manual the physician can fruitfully review, both with a view toward further sharpening the diagnosis, and with a view toward selecting alternative, combined, or successive drugs for treating the patient.

For another example, consider the case in which a manufacturer desires to offer a given level of customer service (some proportion of "stockouts" or "backorders") from the inventory necessary to supply products to customers. The customers' demands for products are fluctuating, and the manufacturing operation is most profitable if products are made in economical lot sizes. The problem of the manufacturer is to match these two opposed factors and at the same time minimize the costs of the inventory. A conceptual aid the manufacturer can get some help from is simulation. This allows experimenting with various alternative arrangements, assuming various alternative demand and production patterns. This experimentation can be carried out entirely in terms of information manipulation without disrupting either manufacturing or inventory operations, or customer relations, and the result can be used as an indication of the lowest cost alternative policies that the manufacturer might try to adopt.

Features of Needed Conceptual Aids in Applying Data Processing

From a study of the conceptual aids used in other fields (such as the examples just reviewed), and from a study of the problems in the data processing field as reviewed earlier in this paper, some of the characteristics or features of a practical conceptual aid can be described. In fact, a few of these features have been mentioned in the reports on the little work on conceptual aids that has been undertaken so far in the data processing field.²

Eight features of a conceptual aid can be listed here as being of special value to personnel working in the data processing field. First, of course, a conceptual aid should be helpful, easy, and quick to use. Second, its use should be a low cost operation. These two features, however, can exist only because other features exist, such as those discussed below.

Rule for Selecting Significant Details

Third, a conceptual aid should be able to tell personnel in the field what is significant for him to look for in their data gathering operations. That is, it must tell them what is significant to their work. The situation is somewhat like driving a car: a person who is teaching himself to drive attempts normally to respond to a large

number of stimulæ that a trained driver would ignore as extraneous. The training a driver receives from a teacher provides a guide to what is significant to the accomplishment of the task at hand. In a similar manner, it would be desirable to have some type of conceptual aid that would provide a guide during work on data processing systems to what is significant to respond to in the accomplishment of the job.

Rules for Measuring

Fourth, a conceptual aid should be able to tell personnel in the field what to measure and what units of measure to use. This feature is an extension of the third feature because it is concerned with how a factor can be measured in order to make that factor most meaningful. Present experience has shown the difficulty of working quantitatively with some of the factors, even some of the very detailed ones. It may be that much of the detailed work performed in the development of data processing systems at present reflects in part the inability to measure significant factors in conceptually meaningful terms.

Rules for Time and Cost Estimates

Fifth, a conceptual aid should be able to provide to personnel in the field some guidance on how to manipulate the significant factors to obtain close estimates of the cost and time needed to perform data processing operations with particular configurations of equipment, personnel, and methods. At present, making time and cost estimates for data processing operations is mostly a matter of judgment and guesswork, and the accuracy of most estimates has reflected this. In part, because of the large number of details that appear to affect time and cost of operation, at present, it is not clear how to take the details into account in estimating.

Rules for Analyzing Alternatives

Sixth, a conceptual aid would be helpful to personnel working on the development of data processing systems if it made possible a "gaming" of alternative systems designs. Thus, it would be desirable to be able to hold most of the factors constant but to change others, and then to manipulate conceptually the relations among the factors in the systems design. This might include simulating the operation of the alternative systems to obtain an indication of the consequences on the time, costs, and other measures of the effectiveness. The inability to do such manipulation at present is mostly attributable to the lack of any way of expressing the essential and relevant parameters of data processing systems (let alone knowing what these parameters are). If it were possible to manipulate conceptually the parameters, personnel could "try out" (experiment with) alternative systems designs in order to obtain an indication of their effectiveness in practice.

Rules for Approaching Automatic Coding

Seventh, a conceptual aid would be helpful to personnel in the field if it could be used to produce an outline of the program data needed for applying automatic coding techniques.³ To use such techniques requires writing general instructions in the special language of

² See, for example, Abstracts Number 32 and 33 in *Computers and Automation*, August, 1958, p. 18.

the technique. The problem personnel face is one of which instructions to write, and in what order. If a conceptual aid could be used to provide even a summary of what to write and in what order, it would be helpful to personnel working on the development of data processing systems.

Rules for Estimating Organizational Effectiveness

Eighth, a conceptual aid would be helpful if it could be used to obtain an indication of how changes in a data processing system would cause changes in organizational effectiveness (the organization might be a business firm, a governmental agency, etc.). Organizational effectiveness is dependent upon a large number of factors other than data processing performance, but data processing performance is one of the essentials for the maintenance of an organization and for the achievement of organizational objectives. Since the ultimate aim of data processing in an organization is to contribute to the organizational effectiveness, it would seem desirable to have some means of evaluating alternative data processing systems in terms of that contribution. To be able to do this seems to be a more remote desirable fea-

ture of a conceptual aid than those listed previously, but none the less desirable.

In conclusion, it can be observed that apparently none, and no combination, of the available bodies of knowledge or accumulated experience has provided as yet, a fabric of conceptual aids having the features just listed. Yet from the problems confronting personnel in the data processing field, the need for conceptual aids seems clear. For example, automatic coding techniques serve in part as a conceptual aid in the coding stage of data processing work (and to a lesser degree in the programming stage). The contribution of these techniques has been widely pointed out. What is needed perhaps, is some technique that would be even more powerful as a conceptual aid, and that would be especially helpful in the systems analysis and system design stages.

3 Automatic coding techniques, it should be noted, are primarily a way of stating a set of directions, a way of guiding data processing performance. They are not primarily a way of stating the character of the application, or of framing a practical and economic definition of the situation that is to be met by doing the data processing operation.

If you who read this report have not previously heard of the Working Group for Better Education, and would like more information, please write us.

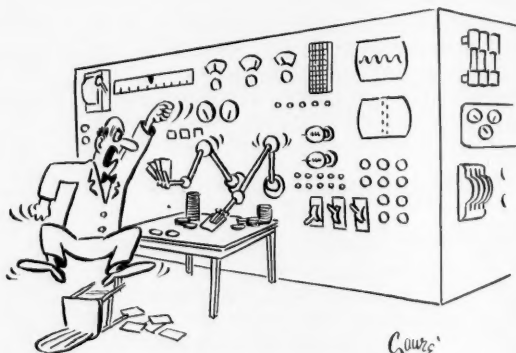
BETTER EDUCATION — TOPICS AND AREAS FOR WORK

The 450-odd enrollment blanks and the 180-odd completed questionnaires have reported a number of topics, factors, and problems in the field of better education.

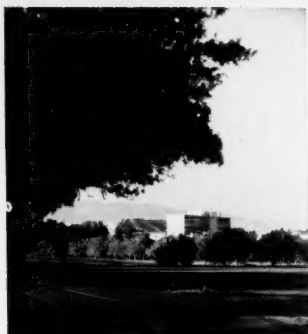
It is possible to group most if not all these topics into a number of classes, which have been called "areas for work," as follows:

1. Computers and Data Processing
 - A. Teaching computers and data processing to high school students
 - B. Working computer models for school use
 - C. Automatic teaching machines
2. Curriculum
 - A. Mathematics
 - B. Arithmetic
 - C. Logic and reasoning
 - D. Sciences
 - E. Reading and phonics
 - F. English and communication
 - G. Foreign languages
 - H. New mathematical topics: binary arithmetic, Boolean algebra, set theory, etc.
3. Measurement and Standards
 - A. Verifying the quality of education produced
 - B. Credentials for teachers
 - C. Stricter standards for college entrance
 - D. Improvements in testing
4. Teachers
 - A. Higher teacher salaries
 - B. More teachers so as to attain smaller classes
 - C. Summer courses and institutes for teachers
 - D. Better teachers
 - E. Training a parent to be a teacher
5. Students
 - A. Motivating students to want to learn, and learn thoroughly
 - B. How a student is to deal with a poor teacher
6. Social Aspects
 - A. More funds for education
 - B. Use of community resources in professional people
 - C. Interaction between schools, government education departments, teacher colleges, parents, teachers, textbook publishers, etc.
 - D. Separation of students by ability
7. Miscellaneous
 - A. Goals of education
 - B. Methods of learning

GAME PLAYING BY COMPUTER



"You're cheating!"



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The new Ramo-Wooldridge Laboratories in Canoga Park provide an environment for creative work in an academic setting. Here, scientists and engineers seek solutions to the technological problems of today. The Ramo-Wooldridge research and development philosophy places major emphasis on the imaginative contributions of the members of the technical staff. ■ There are outstanding opportunities for scientists and engineers. *Write Dr. Richard C. Potter, Head, Technical Staff Development, Department 12-H.*



THE RAMO-WOOLDRIDGE LABORATORIES

A DIVISION OF THOMPSON RAMO WOOLDRIDGE INC.
8433 FALLBROOK AVENUE, CANOGA PARK, CALIFORNIA



An electron device permits scientists to study the behavior of charged dust particles held in suspension.

FIRE CONTROL COMPUTERS — THEIR DEVELOPMENT

Walter A. Murphy

Hyde Park, Mass.

No science has developed faster in the past one hundred years than gunnery fire control. Since 1850 it has grown from a simple gun tube controlled by human judgment and muscle to a near-human system relentlessly searching for its target, tracking and predicting the target's future position, and firing a projectile to intercept and destroy it. Some form of judgment or computation has always been a necessary part of gunfire control and so many factors changed with the development of gunnery that a computer became necessary as the "brain" of the fire control system.

The "Baby Ford"

One of the earliest, and perhaps the simplest, computers ever used by the U.S. Navy was produced by the Ford Instrument Company and performed three functions: it computed range rate; it computed bearing rate; and it generated present range. Called the "Baby Ford," this little pot-like rangekeeper was a real mechanical brain in its day. Operated by one man, it contained: a clock escape-mechanism and a spring motor arrangement for constant time; a range integrator for generating increments of range; two component solvers (target and own ship), for resolving movements into components in the line of sight and across it; a deflection converter for converting deflection rate into mils (thousandths of a right angle); and a number of differential gear assemblies for algebraic sums. Corrections to the range or deflection were introduced by hand cranks to maintain accuracy in the solutions.

Though the Baby Ford was born into the fire control world long before World War II, the student at Fire Control School in 1942 grasped fire control computer principles by disassembling and reassembling the instrument and watching it grind out advance range and sight deflection.

But this basic rangekeeper did not adjust for many other elements which were to make fire control one of the most complicated and challenging mathematical problems in military history. Already present were variations in wind, gun ballistics, and initial projectile velocity to complicate the problem. Soon the range itself increased tremendously with new gun design and the advent of radar detection. Then the third dimension presented itself before the gunner's sights as the flying target appeared high above the horizon. Finally this new target closed the range many, many times faster than did the sea-borne ships of the surface problem. A much shorter solution time with more precision was the demand for effective defense against the air target.

Fire Control Computers in World War II

Computers went on being called rangekeepers even as we entered World War II. Between the "eyes" of the fire

control system (the rangefinder), which furnished intermittent range values, and the muscles (the gun mount) which had to be properly positioned and fired, some instrument had to translate intermittent target range and bearing values continuously into target course and speed values. The instrument had to "keep range" between rangefinder observations. During World War I rangekeeping was done on a plotting board, but this operation was broadened and quickened by the Baby Ford of 1917.

Many kinds of computers appeared during World War II and each was designed for a specific battery capability. They varied in size and complexity from the simple and small lead-computing gunsights to the giant, complex Mk I Computer. For the heavy machine guns — 40mm, 20mm, and 37mm — the on-carriage, lead-computing gunsights automatically computed lead according to target range and deflection. The gunner positioned the gun by smoothly traversing (traversing) the gun and sight until the sight's reticle was on the target. Thus the Mk. 14 gyro-linkage gunsight was a simple computer and director combined. A prototype of the gyro sight knocked 32 Japanese planes from the sky in one battle during the early years of World War II.

The Mk. I Computer was designed to meet the demand for greater fire power against faster enemy planes and long range guns. It did a bigger job than its predecessors and was more automatic and precise. Not only did it transmit corrected gun elevation and bearing orders to the power drives for the large calibre guns, but it transmitted also sight angle and deflection to the guns sights. This was a precaution against damage to the automatic remote control mechanisms: without automatic control, the local manual control could be employed as long as the orders flowed to the sights and as long as the gunners could train the guns manually to follow these orders as they were transmitted to and appeared on the dial indicators. The Mk I is regenerative, also, and can apply its data to the rangefinder and director, driving them to remain constantly on target. The Mk I, with many component solvers, differentials, integrators and multipliers, is probably ten times the size of the "Baby Ford" and requires many more skilled operators.

The "Skysweeper"

A revolution in weapons system mobility came along with the Army's 75 mm "Skysweeper." The "Skysweeper," a fully-automatic weapon replacing the old .50 calibre and 40 mm automatic air defense weapons, featured an on-carriage fire-control system which made the weapon operationally selfsufficient. Its radar scans the sky, picks up aircraft, locks on, and then feeds the target information to the computer located on the side of the gun. The computer

predictions, based on target speed, course, range, and also on the Skysweeper's gun ballistics, positions the gun continuously for a hit. The Skysweeper's computer reflected the trend towards removable unit electronic chassis which can be slipped from their racks like tiny drawers and replaced in the process of troubleshooting.

Airborne Fire Control

Surface fire control had progressed through many phases and applications, from the Ballista of ancient Greece to the Skysweeper of modern warfare. Computations ranged from simple elevation tables and wind compensations to the electronic brain controlling and positioning tons of steel gun mount. But now fire control was being squeezed into a new realm where tons of steel were not permitted and there was no room for a brain such as the Mk I Computer. Fire control was becoming airborne.

The air problem offered as great a challenge to fire control designers as the surface or underwater problem. There were plane movement parameters, such as side slip, angle of attack, etc., some of which seemed impossible to measure. Ranges closed as fast as two jet planes approaching each other at near sonic speeds. Available space for detection, acquisition, and computing equipment restricted fire control design to miniaturized components and special configuration. "Make it fit," was the cry, "but don't change the shape or size of the plane in order to do so."

In 1946 the first project to develop a flight line computer was begun by the U.S. Navy. In 1949 an F7F Navy fighter carried the computer in flight. Accuracy within a fraction of a degree was obtained up to 30,000 feet altitude. Later the jet fighters tried it in their speed ranges. True air speed and relative air density were added to the original flight line computer's angular parameters. Again a fraction of a degree of accuracy was obtained.

All kinds of computers were introduced to handle the problem elements of the airborne fire control and flight control — angle of attack computers, central air data computers, true air speed computers, to name only a few. To understand the job of the fire control computer in the interceptor's fire control system, for instance, one must first know what the system does for the plane and pilot. The system helps the pilot locate his target at long ranges, directs the pilot to fly the correct attack course once the target is acquired, and indicates the correct time for armament firing — and perhaps fires the armament automatically. After the radar has detected and acquired the target, it supplies the computer with the target data which is used to compute the attack course and direct the pilot to that course. Though the fire control computer may vary for different types of military aircraft, its basic function is to automatically compute the attack course and supply the orders that guide the plane to that course.

The trend in weapons control is towards the digital computer. It is less costly to manufacture and is more flexible and accurate in problem solving. For some time, though, the technique of using both electrical and mechanical models, or analogs, for certain types of problem solution brought fame to the analog computer. Operational-amplifier computing techniques were employed in the computer of the M-9 anti-aircraft director during World War II, and by 1947 a number of companies began developing analog-computing machines. Next came the analog-to-digital converters and finally an airborne digital computer. Now computation and automation, once accelerated by the world

war demand for accuracy in fire power, are going hand in hand to expand our economy through more efficient mass production.

During the Korean conflict, dynamic battle conditions of high speed jet combat proved once again the importance of accurate, reliable fire control. Though the Russian MIG 15 had better operating altitude, acceleration, and turning radius (and an explosive cannon) than the U.S. F-86, its weak link was the probability of hit. This link was stronger in the F-86 system due to more sophisticated fire control equipment. The F-86 was equipped with a gyro gunsight and automatic radar-ranging. The gyro lead-computing gunsight computed correct lead in inertial space coordinates with minimum dynamic error. The automatic range-finding relieved the pilot of estimating or visually measuring range by stadiametric means. Records showed a ratio of 15 to 1 in favor of the F-86 fire controlled armament.

Airborne Digital Computers

Recently the AN/ASG-14 optical-radar armament control system appeared in the world's newest production aircraft. Lockheed's F-104 employs the new system to detect, locate, and measure range, and compute lead angle. When the radar locks on to the target, the optical sight computes and displays lead angle and serves as an aiming reference for the plane. Essential data inputs to this system are speed and altitude (received from aircraft instrumentation), range to the target (measured by the radar), and angular motion (transmitted from the ship's gyroscope). When a range "bug" appears on the circle of the sight, the pilot maneuvers the plane to align the target with the center of the crosshair on the combining glass, and fires when the effective range is indicated by the range bug's position on the circle.

Out of man's attempt to predict the point of interception for target and projectile have emerged the computer refinements of today. Not only are there computers for every kind of aircraft, gun, and missile, but computers for checking out and testing these weapons in the production phase and at the launch pad.

Some of the newer airborne computers include the RW-30, designed by Ramo Wooldridge Corporation. With a volume of only 4.19 cubic feet and weighing only 203 pounds, it can conduct 4000 complete arithmetic operations per second and consumes very little aircraft power in the process. There is also Digitair, developed by Hughes Aircraft Company, small enough to fit into the cabinet of a 21-inch table model television set. Digitair can make 9600 basic arithmetical computations and render 100 decisions in one second. It can perform all computing functions for flight-navigation, search, and attack in an interceptor mission. Using coded information from control stations on the ground and the airplane's radar, the computer simultaneously takes in 61 different types of information while putting out 30 types.

Computer Testing

There are computers for testing computers. Westinghouse Electric Corp. developed a computer test stand which checks overall performance by presenting 432 bits of information to the fire control computer under test. The computer is required to solve the problem with a high degree of accuracy. Reflecting the modern trend toward automation, this test stand reduced labor requirements by 50%.



Professional Maintenance

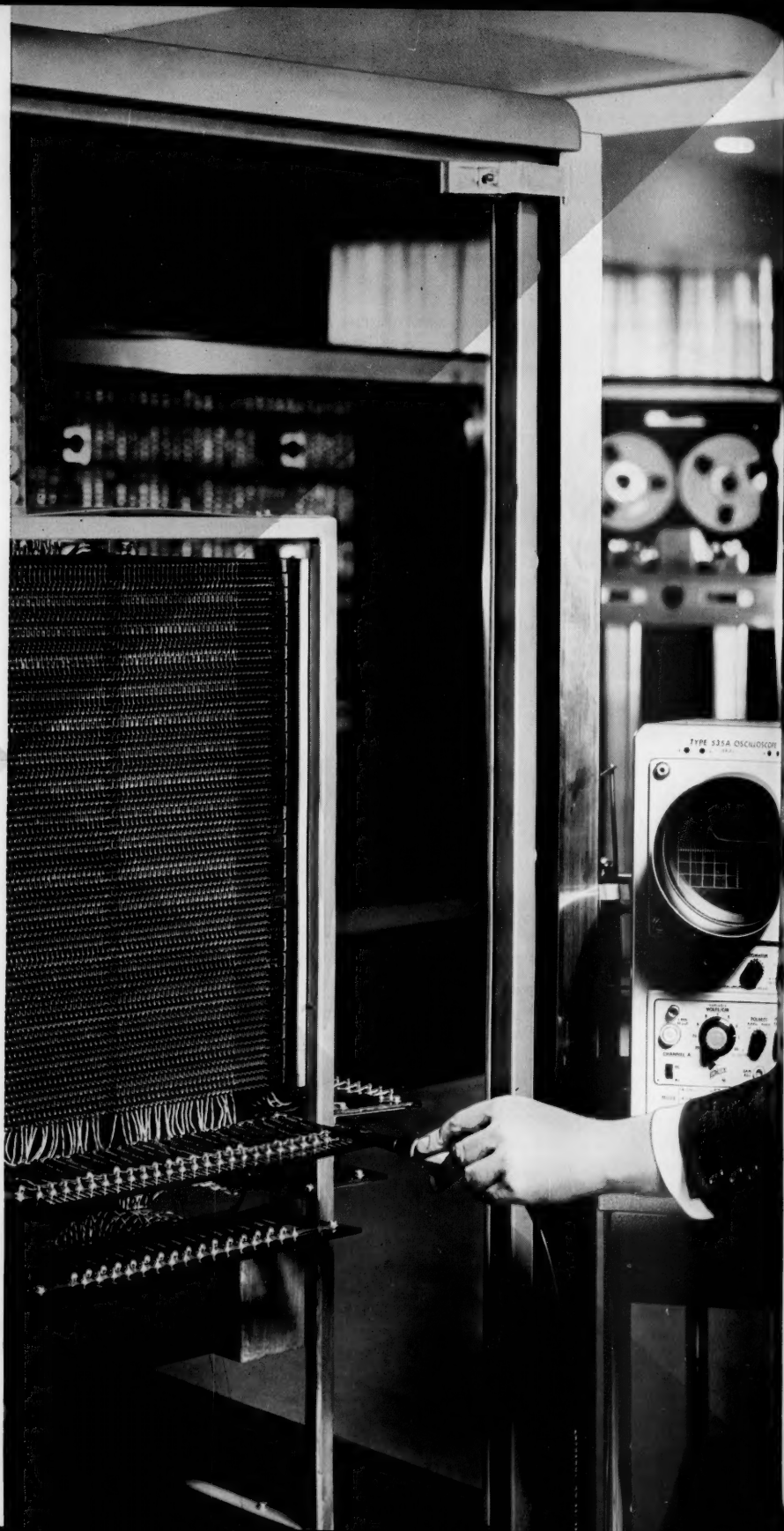
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He is an intensely trained specialist with the dedication of a professional. His career starts with training at an IBM education center. Regularly he returns to school and attends periodic seminars to keep up with the latest advances. As a fully qualified Customer Engineer, he is assigned the responsibility for a customer territory.

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At a modern IBM education center, a class of Customer Engineers watches a technical demonstration on closed-circuit TV.



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Replacement parts are immediately available to IBM service locations from this central supply depot in Mechanicsburg, Pa.



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As for checkout automation, computers are the heart of the massive automatic support systems that check out missile components at launch sites throughout the country. One company has developed an automatic checkout system capable of up to 10,000 decisions a second. This high-speed system incorporates digital computer switching and decision-making techniques and completes preflight checkout in a matter of seconds; or it will provide a complete trouble analysis in minutes. In a typical, automated, checkout operation, a 12-hour, manual test procedure might be reduced to a few minutes and without the human tendency toward fatigue and corner-cutting associated with troubleshooting.

Heart of the Talos missile defense unit is the fire control center where a number of large, complex racks of equipment are used in replacement for the old fire-control plotting and computing equipment, just as the missile itself is replacing the big 16-inch gun of former naval weapon systems. The Navy's Talos and Polaris missile systems have lifted fire control computation and control from its place in the gun armament system.

Computer refinements have moved right into the corporation world within the past ten years. Some very complex and ambitious systems appeared in 1955 — the

ultra-high-speed LARC and the departmentalized BIZMAC, to name just two. In 1956, IBM announced a 10-megacycle, multiple-memory, transistorized computer called STRETCH, and Sylvania Electric Products unveiled a processing system with a nationwide, private communication network 18,000 miles in length. This network connects 71 plants and offices to a centralized Univac which gathers, records, computes, and classifies a variety of organizational functions and activities. Experts think that computers will soon prove a valuable tool in research and development for the space program.

Computers and automation have developed a long way since the Baby Ford rangekeeper. Some people say there is still a long road ahead to reach efficient mass production, system checkout, and information processing. If and when the ideal in industrial computerized automation is reached, perhaps one will look back and call today's computers primitive and inadequate. Yet gunners and fire controlmen of today like to think that the Baby Ford of yesterday was one of the important steps towards industry's ability to produce many more things which were once excluded due to the speed required in data processing.

Data Processing Training in California's Junior Colleges

Part 1

Enoch J. Haga

Vacaville, Calif.

Business data processing (BDP) training has become a reality in many California public schools as a result of the National Defense Education Act of 1958. During the 1958-1959 school year there were 2,075 enrollments in 57 classes, key punch operation not included — twenty schools in nineteen communities participated.

To qualify for aid under the National Defense Education Act, it is necessary to show that the technical training to be offered will aid the national defense. The occupation for which the technical training is provided must lie between a skilled craft and a scientific profession; it must require specialized training directly involving applied mathematics and science; it must be mainly concerned with application of technical knowledge and understanding rather than of manipulative skill; and it must not require more than two years of training. These requirements are such that the junior college seems the best place to provide BDP training; of the twenty schools offering BDP training in 1958-1959, no less than fourteen were junior colleges; these fourteen institutions had 65.7 per cent of the total enrollment of 2,075 students.

As soon as the California State Plan for technician training was approved by the U.S. Office of Education in No-

vember of 1958, the Bureau of Business Education began trying to get junior colleges to participate by beginning experimental pilot programs in the area of BDP. Starting with the school year 1958-1959, six junior colleges have been participating in putting a BDP curriculum into practice: Chaffey College, Diablo Valley College, Foothill College, Orange Coast College, Reedley College, and Stockton College. In California, junior colleges are two-year public secondary schools, grades 13-14; they provide either occupational training or the first two years of college, depending upon the goals of their students. The pioneering work of these institutions will undoubtedly lead to even greater expansion of data processing training within the framework of our public school systems.

A brief description of the achievements of each of the pioneering junior colleges follows:

Chaffey College, Ontario, Calif.

Chaffey College's objectives, much the same as those of the other colleges, were to determine the feasibility of setting up a two-year program to train technicians in the area of BDP. Definitive objectives were to discover the



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extent of the actual need for data processing technicians in the vicinity of the college, to discover job specifications in order to meet employer requirements, to determine needed courses and course content, to find out whether the college had the facilities, staff, and money to participate in a BDP program, to devise a student screening device to insure greatest possible success, and to find a way of putting into effect any program that might be developed.

As a result of these studies, it is now possible to earn the A.A. (Associate in Arts) degree with a major in BDP. During the two-year program, the following courses in the major field would be taken:

DP (Data Processing) 1, Readings in Data Processing, 2 units. Directed readings in periodicals and textbooks dealing with the field of data processing, the general field of business, and office management.

DP 2, Data Sources, Recording and Transmission, 3 units. A study of the laws, production processes, inventory procedures, payroll procedures, and cost control devices which make the collection of data necessary and/or produce data which must be processed. Included is a survey of the media and methods used in transmitting data to the machine accounting department.

DP 3, Oral and Written Reports, 3 units. Same as English 1A.

DP 4, Introduction to Data Processing Equipment, 3 units. Lecture and laboratory study of the uses and operation of standard office machines, electric accounting machines, and electronic data processing machines.



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DP 5, Principles and Practices of Machine Accounting, 3 units. A study of the accepted principles and practices used in the selection of equipment adequate — functionally and economically — to process the data and provide the needed information.

DP 6, Economics of the Firm, 3 units. Geared to provide broader understanding of the data processing conditions which give rise to large industrial organizations and mass production. Careful selection is made of the major economic problems which confront this country.

DP 7, Application of Mathematics to the Computer, 3 units. Same as Electronics 75. Designed to provide the specialized mathematical background necessary to understand the theory of operation of both analog and digital computers. An introduction to the fundamentals of differential and integral calculus, differential equations, binary arithmetic, and Boolean algebra necessary for the study of digital computers.

Other courses are available in the area of data processing, and still more will be offered. The possibility of a work experience program is being investigated.

Diablo Valley College, Concord, Calif.

Diablo Valley College concluded tabulating machine operation offers many employment opportunities; this college also noted that "The junior college should remain alert to any change in responsibility for data processing instruction," and that "Business is showing an increased interest in sharing the responsibilities for training youth in business education." Training at Diablo Valley College would emphasize the "purposes," "potentials," and "principles" of data processing devices and processes. A work experience program is being considered.

At Diablo Valley College it is now possible to obtain the A.A. degree with specialization in Data Processing. Included in the list of courses like Machine Calculation, Systems and Procedures, and the like, is a new business course, Data Processing. According to the report of the college:

Upon completion of the course, the student should expect to be able to read with understanding new literature in the field, to listen and talk intelligently about the subject matter of the course, and to pursue, on his own or in other courses, specific aspects of this field of operation.

The main topics of the course are: factory automation processes, office automation systems, collecting information, processing information, presenting processed information, work simplification, improved manual methods, adoption of man-machine procedures, use of punched-card systems, adaptation to electronic data processing systems, management decisions, and problems in and effects of data processing.

Foothill College, Mountain View, Calif.

A program for training computer programming technicians was developed at Foothill College. Graduates will be programmers with mathematics training, and not mathematicians with programmer training. It is possible to obtain the A.A. degree in Computer Programming. Specific data processing courses are Introduction to Computer Processes, 3 units; Computer Coding and Programming A, B, and C, 3 units each; and Electric Accounting Machine Programming, 3 units.

Recognizing that some students will be interested in scientific applications of data processing, the curriculum has been planned for both scientific and business data processing interests. Therefore, the first two Computer Coding and Programming courses, six units, have been designed for both groups. The third three unit course makes allowance for the two groups to solve seminar-type problems within the areas of their respective interests. Each of the three Coding and Programming courses is progressively more difficult. The IBM 650 and the Datatron 205 will actually be used as much as possible so that students may gain practical experience; the IBM 650 will be used first; then the Datatron 205 during the second half of the second semester; still other machines will be used during the third semester. This college is fortunate in being able to secure machines from Stanford University and the Stanford Research Institute.

The course, Introduction to Computer Processes, will not require any text; texts for Computer Coding and Programming C and for Electric Accounting Machine Programming, have not been chosen. For use in Computer Coding and Programming A and B, McCracken's *Digital Computer Programming*, and Andree's *Programming the IBM 650 Magnetic Drum Computer and Data-Processing Machine*, have been selected. As an example of the type of problem that might be considered in Computer Coding and Programming C, "the problem of scheduling rooms for classes at Foothill College" is mentioned.

Development of a work experience program, designed for the student's final semester, is suggested.

Orange Coast College, Costa Mesa, California

At this college the purpose of the experimental program was "to develop the BDP curriculum, instructional aids, library, lab facilities, and recruitment materials." An introductory course in BDP was taught and a basic two-year curriculum established; as a result the A.A. degree may be earned with a BDP major, consisting of 26 units in BDP, mathematics, and accounting. Courses included in the major program are:

BE 2, Business Data Processing, 3 units, one semester. "Introduction to the basic methods, techniques, and systems of manual, mechanical and electronic data processing. . . ."

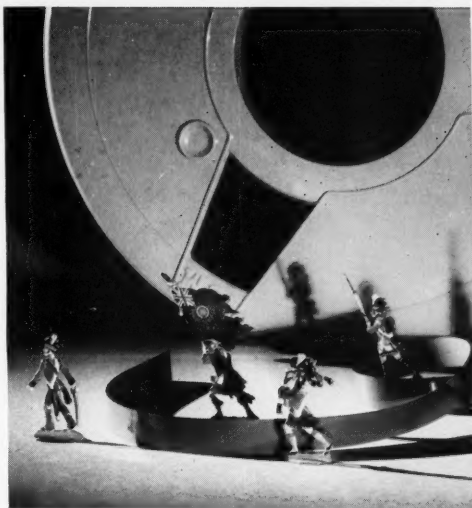
BE 6A-6B, Data Processing Machines, 6 units, two semesters. "(6A) Essentially covers punched tape equipment, flexowriter, basic machines operation, introduction to wiring. (6B) Advanced wiring on the collator, accounting machine, and calculating punch."

BE 8A-8B, Computer Programming, 6 units, two semesters. "(8A) Introduction to computers, input processing and output computer hardware, computer language, processing techniques, and introduction to programming. (8B) Computer programming of data processing systems employing some advanced programming techniques."

BE 7, Data Processing Systems, 3 units, one semester. "Introduction to systems analysis and construction of systems; development of data processing applications from manual systems."

[To be continued in the September issue of *Computers and Automation*]

COMPUTERS and AUTOMATION for August, 1960



wanted: WAR GAME PLAYERS

Very large-scale air-battle digital computer simulations are now going on at the Washington Research Office of **tech/ops**. Present operations call for **top-flight mathematicians, mathematical statisticians, senior programmers, operations research analysts**.

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Readers' and Editor's Forum

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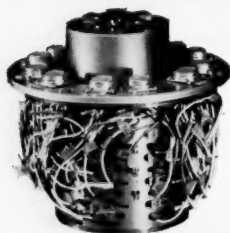
This memory is part of a language translator from Russian to English which was demonstrated in May, and is being developed by International Business Machines Corp. in cooperation with the U.S. Air Force.

See the article starting page 6.

GLOSSARY OF COMPUTER TERMS

I.

In June we finished and sent to the printer the fifth edition (1960) of the "Glossary of Terms in Computers and Data Processing" prepared by **Computers and Automation**. 96 pages long, this edition contains over 860 computer terms and expressions with their definitions. Our last



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edition, the fourth, published October 1956, contained 490 terms.

In these definitions, we have tried to explain the terms so that a person new to the computer field could understand them. We hope the new glossary will be helpful to many persons in the computer field.

For details of availability of this glossary to subscribers and to non-subscribers to **Computers and Automation**, see further information on page 25.

II.

The interest and importance of the meaning of terms is recognized in a current series of four advertisements by Daystrom, Inc., Murray Hill, N.J. These ads explain: "feedback; memory; solid state; signal and noise." The feedback ad illustrates the meaning of feedback with a tight-rope walker and a motorist driving a car. The memory ad illustrates the meaning of memory in the setting of a drill press, and the punched tape of a player piano. The solid-state ad clarifies some of the newly important properties of solids which have led to transistors and other important new devices. The ad on signal and noise discusses information flowing in a communication channel, contamination by distortions, and methods such as removal, filtering, feedback, and redundancy for dealing with the distortions. Daystrom is to be congratulated for using its advertising to spread useful scientific information and understanding.

THINKING BY MACHINES

(Continued from the discussion in the May, 1960, issue of **Computers and Automation**, p. 19)

III. From: Charles Block

New York, N.Y.

Part II of the article "Thinking by Machines" (May 1960 issue) requires an immediate rebuttal: namely, *machines can't think*. There are several misleading analogies and questionable statements in this article. For example, it is asserted that "A completely uneducated human being would be one deprived, from birth on, of any contact with other human beings; such a person cannot think, cannot even communicate." (Emphasis is mine.)

I'm dubious that this conclusion was derived empirically and amazed that it can be deduced theoretically.

In general, the article has confused the products of thinking with the process of thinking. I'd refer the interested reader to an article by M. V. Wilkes, "Can Machines Think?" This article was reprinted in the October, 1953 issue of the *Proceedings of the I.R.E.* (Vol. 41, No. 10).

IV. From the Editor

There are a few records in the literature of human beings brought up without any contact with human society, two examples of wolf children in India, and one example of a wild boy in France. These examples appear to confirm the statement that "such a person cannot think, cannot even communicate." Lack of contact by young animals at the most crucial periods of their learning and absorbing information, with other animals of the same species, produces very marked variations of the behavior of these animals, and in the case of human beings, lack of contact with other human beings and with a culture seems definitely to prevent thinking and communication.

I have read the article by M. V. Wilkes, "Can Machines Think?", and disagree with some of the points that Dr. Wilkes makes.

Of course, a good deal of the argument depends on the definition of "thinking."

Until the participants in the argument have agreed on the definition, there is not too much that can be solidly established.

V. From a commentator on the Western Joint Computer Conference as reported in the "Automatic Data Processing Newsletter" of May 16, 1960, published by John Diebold and Associates, New York:

With regard to learning and problem-solving machines, the tendency used to be for experts in computers to keep admonishing laymen that "giant brains" is a misnomer and that machines really can't think. Now we are hearing more and more about "perceptive" and "adaptive" computers. In the session "Learning and Problem-Solving Machines" speakers described results in areas normally reserved for human reasoning. The most significant paper was by H. Gelernter of IBM outlining a 20,000 word program which indoctrinates an IBM 704 in the art of proving theorems in elementary Euclidean geometry.

COMMENTS FROM READERS

I. From Louis Sutro

Needham, Mass.

The yellow pages at the center of your magazine have proved useful again. The announcement contained there of Potter Instrument's fast new miniature printer has led us to seek more information about it.

II. From Walter E. Misdorn

Control Data Corp.

South Plainfield, N.J.

I heartily approve of your new "Across the Editor's Desk."

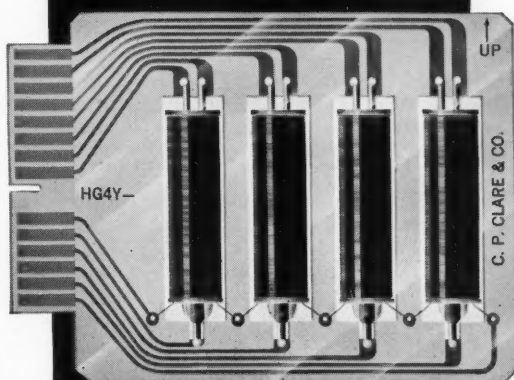
I personally like articles describing applications and comparison of buy or lease — but disapprove of those dealing with general education.

III. From Whitfield Cobb

Greensboro, N.C.

May I add my compliments on the editorial slant of *Computers and Automation*? I am delighted to find a publication concerned with both technical knowledge and ethical motivation.

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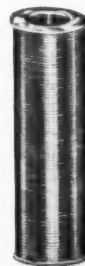
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- Aug. 8-12, 1960: Pacific General Meeting of the American Institute of Electrical Engineers, San Diego, Calif.
- Aug. 10-12, 1960: Annual Meeting G-15 Users' Exchange Organization, Pittsburgh Hilton Hotel, Pittsburgh, Pa.; contact Dr. Jerry C. L. Chang, Richardson, Gordon & Associates, 3 Gateway Center, Pittsburgh 22, Pa.
- Aug. 23-26, 1960: WESCON, Ambassador Hotel and Pan Pacific Auditorium, Los Angeles, Calif.
- August 23-26, 1960: Annual Meeting of the Association for Computing Machinery, Marquette Univ., Milwaukee, Wisc.
- Aug. 25-26, 1960: RUG Meeting (Recomp Users Group), Denver, Colo.
- Aug. 29-Sept. 3, 1960: American Mathematical Society Meeting, Michigan State Univ., East Lansing, Mich.
- Aug. 29-Sept. 3, 1960: 4th International Symposium on Information Theory, London, England.
- Sept. 5-10, 1960: Second International Conference on Operational Research, Aix-en-Provence, France; contact John B. Lathrop, Operations Research Div., Lockheed Aircraft Corp., Burbank, Calif.
- Sept. 7-9, 1960: 1st Joint Automatic Control Conference, sponsored by ISA, AIChE, AIEE, ASME, IRE, at Mass. Inst. of Technology, Cambridge, Mass.; contact Dr. James Mozley, Johns Hopkins University, Baltimore, Md.
- Sept. 12-16, 1960: Share XV Meeting, Pittsburgh Hilton Hotel, Pittsburgh, Pa.; contact E. B. Weinberger, Gulf Research & Development Co., P. O. Drawer 2038, Pittsburgh 30, Pa.
- Sept. 19-21, 1960: 5th Annual Symposium on Space Electronics and Telemetry, sponsored by The Institute of Radio Engineers, Inc., Shoreham Hotel, Washington, D.C.
- Sept. 20-24, 1960: Symposium on the Numerical Treatment of Ordinary Differential, Integral and Integro-Differential Equations, University of Rome, Rome, Italy; contact Prof. A. Ghizzetti, Provisional International Computation Ctr., Palazzo degli Uffici, Zona dell'EUR, Rome.
- Sept. 22-23, 1960: Fall Meeting of the Univac Users Association, Washington, D.C.; contact W. C. Rockwell, Remington Rand, 315 Park Ave. So., New York 10, N.Y.
- Sept. 26-30, 1960: 3rd ISA Instrument-Automation Conference and Exhibit of 1960, and ISA's 15th Annual Meeting, New York Coliseum, New York, N.Y.
- Sept. 30-Oct. 1, 1960: Third Annual Northwest Computing Conference, sponsored jointly by the Northwest Computing Association and the Oregon State Board of Higher Education, Portland, Ore.; contact George G. Town, Program Comm. Chairman, Oregon State College, Corvallis, Ore.
- Oct. 4-6, 1960: Meeting, Burroughs 220 Computer User Group (CUE), Philadelphia, Pa.; contact Merle D. Courson, First National Bank of San Jose, San Jose, Calif.
- Oct. 9-14, 1960: 1960 Fall General Meeting of American Institute of Electrical Engineers, New York, N.Y.; contact Clarke S. Dilkes, Assoc. Dir., Burroughs Corp. Research Ctr., Paoli, Pa.
- Oct. 10-12, 1960: National Electronics Conference, Hotel Sherman, Chicago, Ill.; contact Prof. Thomas F. Jones Jr., NEC Program Chairman, School of Electrical Engrg., Purdue Univ., Lafayette, Ind.
- Oct. 10-14, 1960: American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.
- Oct. 17-19, 1960: Symposium on Adaptive Control Systems, sponsored by Long Island Section, Institute of Radio Engineers, Garden City Hotel, Garden City, L.I., N.Y.; contact F. P. Caruthers, Symposium Chairman, c/o Specialties Inc., Skunks Misery Rd., Syosset, N.Y.
- Oct. 19-26, 1960: Second Interkama — International Congress and Exhibition for Measuring Techniques and Automation, Düsseldorf, Germany.
- Oct. 20-22, 1960: 7th International Meeting of the Institute of Management Sciences, with session "Use of Computers in Simulation," Hotel Roosevelt, New York, N.Y.; contact James Townsend, 30 E. 42 St., New York 17, N.Y.
- Oct. 26-27, 1960: The 1960 Computer Applications Symposium, sponsored by Armour Research Foundation of Illinois Institute of Technology, Morrison Hotel, Chicago, Ill.; contact Andrew Ungar, Armour Res. Foundation, 10 W. 35 St., Chicago 16, Ill.
- Nov. ?, 1960: 13th Annual Conference on Electronic Techniques in Medicine & Biology, sponsored by ISA with IRE and AIEE cooperating, Washington, D.C.
- December 13-15, 1960: Eastern Joint Computer Conference, New Yorker Hotel, New York City; contact Dr. Nathaniel Rochester, IBM, Yorktown Heights, N.Y.
- Jan. 16-19, 1961: ISA Winter Instrument-Automation Conference & Exhibit, conference at Sheraton-Jefferson Hotel, exhibit at Kiel Auditorium, St. Louis, Mo.; contact William H. Kushnick, Exec. Dir., ISA, 313 Sixth Ave., Pittsburgh 22, Pa.
- March 16-17, 1961: Conference on Data Processing Techniques and Systems, sponsored by Numerical Analysis Laboratory at the University of Ariz., featuring "Discussions of data processing problems in engineering and scientific research," Tucson, Ariz.; contact Miss Betty Takvam, Conference Secretary, Numerical Analysis Lab., Univ. of Ariz., Tucson, Ariz.
- Sept. 6-8, 1961: 1961 Annual Meeting of the Association for Computing Machinery, Statler Hotel, Los Angeles, Calif.; contact Benjamin Handy, Chairman Local Arrangements Committee, Litton Industries, Inc., 11728 W. Olympic Blvd., W. Los Angeles, Calif.
- Sept. 11-15, 1961: The Third International Congress on Cybernetics, Namur, Belgium; contact Secretariat of The International Association for Cybernetics, 13, rue Basse Marcelle, Namur, Belgium.

THE GE-225 COMPUTER

General Electric Co., Computer Dept.
Deer Valley Park
Phoenix, Arizona

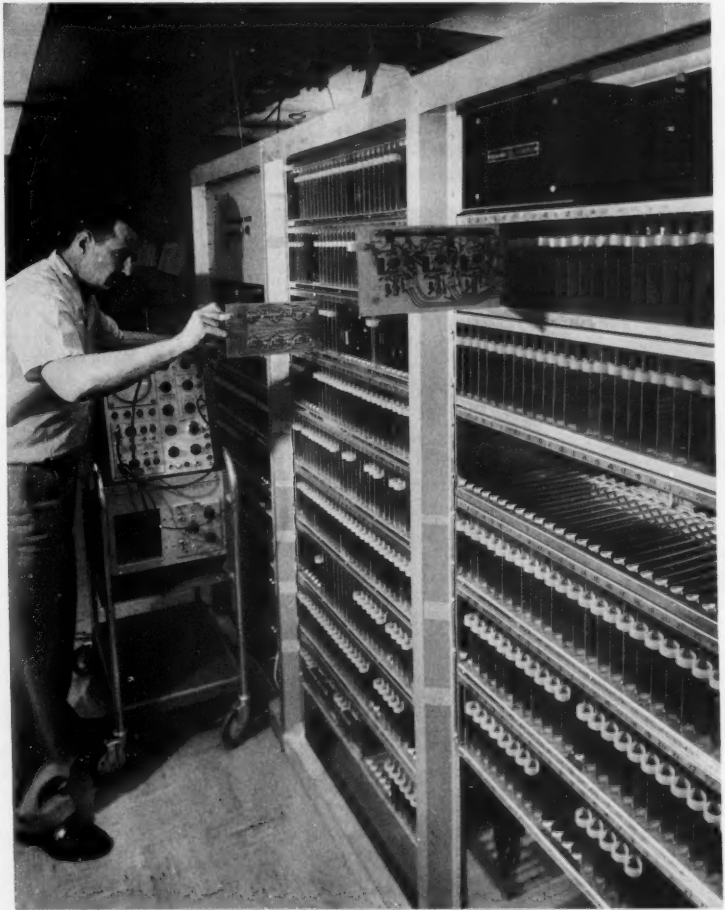
The medium-priced, general-purpose computer market contains a new all-transistorized, information-processing system. The new machine, designated GE-225 and announced in June, is aimed to serve a wide range of uses, from scientific applications to complex business data-processing. The computer system contains newly-developed "General Compiler" programming technique, which translates English words and symbols into machine language. Thus, the computer can be programmed by people with little training in the language of modern computers.

The new computer has core memory, high-speed computation, low-power requirements, and ability to handle a large variety and quantity of peripheral devices. The computer can add 25,000, five-digit numbers per second, about 10 times faster than medium-priced computers now available. The new computer is priced in the \$125,000 to \$400,000 range -- leasing from \$4,000 to \$12,000 monthly -- depending on peripheral equipment.

During the past six months, more than two dozen orders for the GE-225 have been received. Initial deliveries are expected late this year.

The new computer is the fourth all-transistorized data-processor introduced by the GE Computer Department. Others include: (1) the ERMA system developed for Bank of America, the first commercial all-transistorized machine; (2) the 304, designed to specifications of National Cash Register Company; and (3) the GE-210, developed to serve general requirements of banking, credit-accounting, and utility billing for bookkeeping, and reporting through use of magnetic ink character recognition (MICR).

Several orders have been placed by banks throughout the country for the GE-210, incorporating MICR. The Bank of America is currently handling more than 500,000 documents daily with MICR. The First National Bank of Arizona in Phoenix has begun to process branch accounts by MICR.



Logic plug-in boards for the GE-225 computer

SIX MONTHS REPORT OF INCOME 1960 AND 1959

Thomas J. Watson, Jr., Pres.
International Business Machines Corp.
590 Madison Ave.
New York 22, N.Y.

The gross income from IBM domestic operations for the six months ended June 30, 1960, was \$694,626,974 compared with \$615,371,141 for the six months ended June 30, 1959.

Comparative financial results are as follows:

	Six months ended June 30	
	1960	1959
	(\$ in thousands)	
Gross income from sales, service and rentals in U.S.	\$694,627	\$615,371
Cost of sales, service and rentals and expenses	555,391	496,754
	139,236	118,617
Other income	10,255	6,990
	149,491	125,607
Dividends and interest received from IBM World Trade Corporation	6,850	5,100
Net income before U.S. Federal income taxes	156,341	130,707
Less: Provision for U.S. Federal income taxes - estimated	79,725	66,676
Net income for the period	76,616	64,031
Net income per share (dollars and cents)	\$4.19	\$3.51

DAEDALUS: "COMPLETE THE SQUARE" COMPUTER

Baird-Atomic, Inc.
33 University Road
Cambridge 38, Mass.

Experts in the game called "Completing the Squares" can challenge the electronic wits of a device which arrived in Massachusetts from England on July 14.

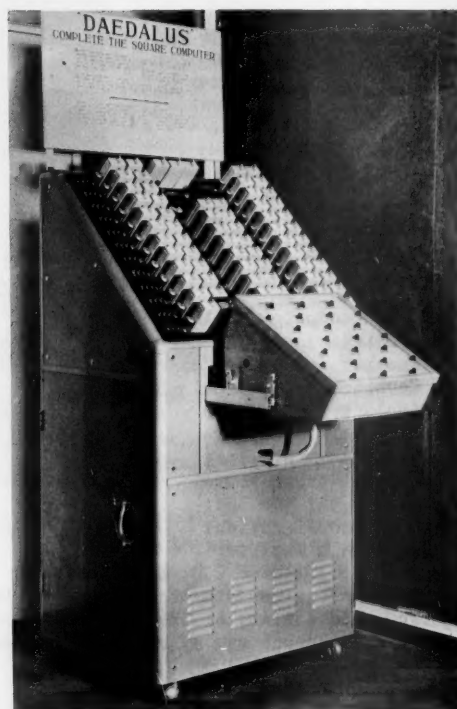
Known as "Daedalus" (in honor of the labyrinth-builder), the machine is actually a slow-speed computer. Etelco, Ltd., of Great Britain constructed it from counting and trigger tubes which they manufacture. Baird-Atomic, their U.S. representative, has borrowed it for display at the Western Electronic Show and Convention in Los Angeles, August 23-26.

In playing the game of "Completing the Squares" each of the two players "draws a line" between two adjacent dots in a 16-dot square -- one line per move. The player who draws the final line for a four-dot square gains one point plus a bonus move. The highest point count wins.

With Daedalus, the human player indicates his move by pushing a button. The metal mind of the machine -- cold cathode tubes programmed in memory and logic circuits -- records his play and reacts with a move of its own choice.

The computer was built to demonstrate the application of the tubes in sensing, storing, and counting circuits. It contains one thermionic tube and 168 cold cathode tubes.

A skilled human player can outplay the machine -- especially if he has the first move.



**SPACE TELEMETRY SYSTEM
OCCUPYING 54 CUBIC INCHES**

**Space Electronics Corporation
930 Air Way
Glendale, Calif.**

For transmitting important scientific information to the earth from deep in space, one of the smallest telemetry systems known will be used by the Air Force for its forthcoming rocket, Journeyman, which will probe space to 30,000 miles. Space Electronics Corp. recently developed this system, which has been named "Digilock" and which will be used to collect and transmit measurements of space phenomena.

The system uses a transmitter with a power output of only 250 milliwatts. The system weighs only $1\frac{1}{2}$ pounds; the transmitter by itself, only about $\frac{1}{2}$ pound. The circuitry takes up 45 cubic inches of space, and the transmitter takes up 9 cubic inches. The system needs only $3\frac{1}{2}$ watts of power; of this, the encoder itself draws one watt of power. Since only 15 hours of operation are required in the mission, the system demands only $1\frac{1}{8}$ pounds of batteries.

Scientific data will be telemetered for virtually the entire flight, starting three minutes after separation of the nose cone. The rate of data transmission will be either 64 or 256 bits per second as may be needed.

The system uses pulse code modulation, and will be designed to handle multiple-signal analog or digital data, which are electronically commutated by the encoder. This particular version of the system requires no new receiving equipment on the ground.

A NEW ELECTRO-OPTICAL RELAY: THE RAYSISTOR

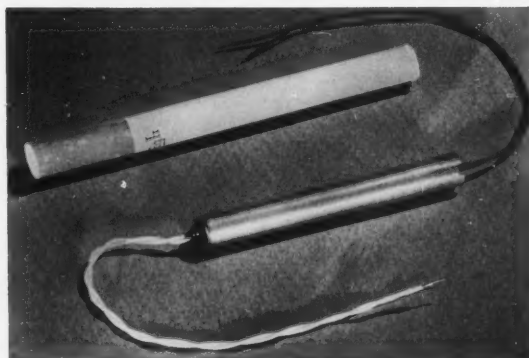
**William Weed
Industrial Components Div.
Raytheon Co.
Newton 58, Mass.**

An electronic device, smaller than a cigarette, that can replace a substantial quantity of relays, potentiometers and commutators in their existing applications, has been developed. It is an electro-optical relay, with a conductance on-off ratio of 1,000,000 to 1, and capable of speeds up to 100 operations per second. It is tubular in construction and has no moving parts. It includes a light source in the control end, which, when excited, actuates a photo-

conductor in the signal end, allowing either AC or DC signals to pass. It has been named the Raysistor.

Outlasting many mechanical relays, the Raysistor has an "on" life of some 2500 hours, irrespective of the number of switching operations. Unlike transistors or vacuum tubes, the Raysistor is non-polar, and its input is completely isolated from the output. It may be used in series or parallel combinations without the introduction of common ground problems; it may be applied to logic circuits and matrices for telemetering or signal commutation.

It can switch without introducing transients in the signal circuit. When used as a potentiometer, it is absolutely free of contact noise. It was developed to provide a high-speed, non-mechanical commutator for use in a spectrum analyzer. It provides an economical means for high-speed repetitive scanning of small banks of filters.



**DIODE FUNCTION GENERATOR WITH
PUNCH CARD MEMORY**

**General Computers, Inc.
9000 West Pico Boulevard
Los Angeles 35, Calif.**

A new concept in programming of a diode function generator is expressed in this equipment now in production. A pattern of holes in a punched card replaces the laborious setting and continual adjusting of potentiometers.

The Functions may be expressed as 20 contiguous line segments, with Slopes ranging from .005 to 10.160 volts per volt. The Absolute Accuracy is 0.1%, and the Long Term Repeatability is 0.02%. The Input and Output Range is plus or minus 100 volts. The Frequency Response is from DC to 10 KC.

15 NATIONAL INFORMATION-PROCESSING SOCIETIES TO CONVENE SECOND WORLD CONFERENCE
SEPTEMBER, 1962

I. L. Auerbach
Auerbach Electronics Corporation
1634 Arch Street
Philadelphia 3, Pa.

The Council of the International Federation of Information Processing Societies in June concluded its first meeting, which took place at the International Computation Centre in Rome, Italy. The Federation was organized at the UNESCO-sponsored First International Conference on Information Processing, held in Paris in June 1959. That Conference was attended by more than 1800 delegates from all parts of the world, and was highly successful in establishing contacts among the scientists in this important field.

The officers elected by the Council of the International Federation of Information Processing Societies during the June meeting were, as president, Mr. Isaac L. Auerbach, representing the National Joint Computer Committee of the United States; as vice president, Professor Dr. Alwin Walther, representing DARA (Deutsche Arbeitsgemeinschaft für Rechen-Anlagen) of Germany (Technische Hochschule, Darmstadt); as Secretary-Treasurer, Dr. Ambrose P. Speiser, representing the Swiss Federation of Automatic Control (IBM Research Laboratory, Adliswil-Zurich).

(Regnecentralen, Copenhagen) will be Chairman of the Program Committee. In addition to the organization of the International Conference on Information Processing, one of the activities of the International Federation of Information Processing Societies will consist of coordinating standards in the field of information processing; a committee for this work will be established. Other programs will be assumed by the Federation's Council as requested by the national technical societies to help the growth of the information-processing field, one of the most important sciences for the future development of technology in the service of mankind.

In other member nations of the International Federation of Information Processing Societies, representation of each country's technical societies is as follows:

Belgium	Association Belge pour l'Application des Methodes Scientifiques de Gestion
Canada	Computing and Data Processing Society of Canada



The Second International Conference on Information Processing will be convened in September 1962 in Germany. Professor Alwin Walther was appointed General Chairman for the conference, and Mr. Niels Ivar Bech of the Danish Academy of Technical Sciences

Czechoslovakia	Commission for Technical Cybernetics Czechoslovak Academy of Sciences
Denmark	Danish Academy of Technical Sciences

Finland	The Finnish National Committee for Information Processing
France	Association Française de Calcul (AFCAL)
Germany	Deutsche Arbeitsgemeinschaft für Rechen-Anlagen (DARA)
Japan	Information Processing Society of Japan
Netherlands	Nederlands Rekenmachine Genootschap
Spain	Instituto de Electricidad y Automatica
Sweden	Swedish Society for Information Processing
Switzerland	Swiss Federation of Automatic Control
United Kingdom	British Computer Society
Union of Soviet Socialist Republics	Academy of Sciences of the USSR
United States	National Joint Computer Committee, representing The Institute of Radio Engineers, the American Institute of Electrical Engineers, and the Association for Computing Machinery

THE CONTROL DATA 160 -- STATISTICS

Control Data Corporation
501 Park Ave.
Minneapolis 15, Minn.

The Control Data 160 is a versatile, solid-state, low-price computer, which will execute 60,000 instructions in one second.

1. **Magnetic Core Storage:** 49,152 bits. Storage cycle time, 6.4 microseconds. Basic add time, 12.8 microseconds. Information read available 2.2 microseconds after start of cycle. Average execution time, 15 microseconds per instruction. 5 megacycle logic. Will handle input-output speeds of up to 65KC.
2. **Operating Mode:** Operation controlled by an internally stored program. Single address logic, one instruction per word.
3. **Programming:** Repertoire of 62 instructions. Ease of programming features flexible addressing modes -- no address, direct address, indirect address and relative address. Complete programming package includes 22-, 33-, 44-bit fixed point arithmetic, floating point, complex floating point, decimal, floating decimal, and algebraic compiler.
4. **Input-Output:** Versatile instructions provided to handle available line of input-output devices: 350 character/second paper tape reader, 60 character/second paper tape punch, electric typewriter, up to 8 magnetic tape handlers (either 15KC or 30KC), card reader, card punch, and line printer.
5. **Uses:** Applies in engineering and scientific calculation, real-time data processing, data conversion, data logging and data acquisition, industrial control, communications systems, statistical and business data processing.
6. **Performance:** Equal to or better than that of many large-scale computers in use today.
7. **Time to Learn:** Experienced programmers can learn the 160 in one day. A two-week course is available for inexperienced personnel.
8. **Price:** \$60,000 for the basic system.

NEW FIELDS OF INSTRUMENTATION: SEA SPACE

Instrument Society of America
313 Sixth Ave.
Pittsburgh 22, Pa.

At the annual meeting of the ISA Sept. 26-30 in New York, there will be a number of sessions devoted to underwater investigation and instrumentation. The world is on the threshold of two frontiers -- outer space and sea space; interest in sea space has increased because of advances in submarine exploration, and in submarine warfare.

The sea space scientist and the instrument engineer will be brought together at the presentation of about twenty-five papers on advances in underwater instrumentation and automation, and obstacles encountered working entirely within a liquid medium.

SIMULATED ICBM ATTACKS ON U.S. ANALYZED IN BMEWS DATA-PROCESSING SYSTEM

Radio Corporation of America
30 Rockefeller Plaza
New York 20, N.Y.

Simulated mass attacks on the United States by intercontinental ballistic missiles are being expressed in the form of magnetic tape, and then fed for test purposes into two huge electronic data processing systems at Van Nuys, Calif.

The systems, now located at RCA's West Coast Missile and Surface Radar plant at Van Nuys, will be moved this fall to headquarters of the North American Air Defense Command at Colorado Springs and the Strategic Air Command at Omaha, Neb. There, they will process, with lightning speed, all signals flashed back from the radar bases of the Ballistic Missile Early Warning System, for which RCA is prime contractor to the Air Force.

Successful integration tests of the systems have occurred.

The BMEWS bases will be at Thule, Greenland; Clear, Alaska; and Yorkshire, England. The Thule base, nearly completed, already has sent its radar beams across the polar region on a test basis. Ultimately they are intended to provide a radar screen extending well over 2,000 miles across the top of the world to provide at least 15 minutes of warning in the event of an ICBM attack.

In the event of an enemy ICBM attack BMEWS target information would be communicated instantaneously to the NORAD and SAC combat operation centers where automatic tactical displays provide U.S. strategic commanders with an over-all picture of the threat minutes after it is initiated. On the basis of the information in these displays, the NORAD and SAC commanders will decide on appropriate air defense and retaliatory operations.

The two systems at Van Nuys, one destined for NORAD and the other for SAC, are now linked for test purposes by a communications "loop" through San Fernando, ten miles to the north. Their operation when in actual service was described as follows:

The data transmitted from all forward sites are received at Colorado Springs and Omaha and combined and processed in a central Display Information Processor (DIP). Missile threat information and threat summary data indicating detailed raid information are pro-

jected on a large screen. Site equipment status is shown on a small console in a monitoring room.

Automatic processing of a missile attack from the moment of recognition of a mass raid by the site computers to the display of the threat information at NORAD and SAC requires an average time of about eight seconds. Data on individual missiles will be displayed at NORAD within three seconds after discrimination of individual missiles.

In the event of failure of automatic transmission equipment, a manual back-up method is available for receiving data by phone or teletype and mechanically inserting it into the computer display equipment.

ADVERTISING AGENCY APPLICATION OF ELECTRONIC COMPUTERS

Young & Rubicam, the nation's fourth largest advertising agency, has entered the electronics age with the acquisition (at a cost of nearly \$1,000,000) of its own electronic computer system -- the Remington Rand UNIVAC File-Computer Data Automation System -- Model 1. Y & R believes that it is the first agency in the country to have such a system.

Installed in the agency's New York office, the machine can handle 32 accounting operations previously processed by tabulating machines.

The new machine will relieve the media department of two of its most time-consuming functions -- estimating and preparing insertion orders for various media. All of the various rate and date information necessary to determine ad insertion costs are placed on a single spool of magnetic tape and fed into the machine. Any needed fact or figure -- or hundreds of them -- can be removed in a matter of seconds complete with necessary computations.

For example, to find the cost of a proposed newspaper schedule in a media selection of 100 markets, UNIVAC will search through its store of information to find the line cost of each newspaper, adjust this figure to the client's contract rate, multiply this sum by the proposed lineage, subtract the cash discount and agency commission and give the final figure for each schedule. Total time -- three or four minutes.

The approved schedule, along with the individual publication's address and any special instructions that apply, can then be printed on regular insertion order forms at the rate of 60 orders a minute.

BOOKS and OTHER PUBLICATIONS

Moses M. Berlin
Cambridge, Mass.

WE PUBLISH HERE citations and brief reviews of books and other publications which have a significant relation to computers, data processing, and automation, and which have come to our attention. We shall be glad to report other information in future lists if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / comments. If you write to a publisher or issuer, we would appreciate your mentioning **Computers and Automation**.

Automatic Teaching: The State of the Art / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1959, printed, 198 pp, \$3.25.

This book reports on and evaluates the methods and techniques of the newly developed field of machine teaching. Based on a collection of 16 papers presented at a Univ. of Penn. Symposium, and edited by E. Galanter, the text offers twenty-one chapters with information on programming, analysis, a review of factors in learning efficiency, some effects of machine learning, and the relationship between automated teaching and the student. The final chapter deals with certain psychological educational issues related to teaching machines.

Greene, Jay R. and Roger L. Sisson / Dynamic Management Decision Games / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1959, printed, soft cover, 84 pp, \$2.95.

This book presents the case for wider use of dynamic management decision games. It presents seven noncomputer business games which enable the reader to become familiar with the techniques involved. Ten chapters point out the value of these games, how to construct them, and how to direct and modify them. A bibliography follows the text. Kits for playing these games may be obtained from the authors' firm, Canning, Sisson, and Associates, 1140 South Robertson Boulevard, Los Angeles 35, Calif.

Nett, R. and S. A. Hetzler / An Introduction to Electronic Data Processing / The Free Press of Glencoe, Illinois / 1959, printed, 287 pp, \$6.75.

This book has been prepared for those who contemplate using computers for research, business, or government appli-

cations. Eight chapters trace the development of the computer, giving historical background on the industrial process that made data processing a necessity. Topics include, the language of computers, applications, and personnel organization. In an appendix, a description is given of four data processing systems, followed by a bibliography and index.

Langer, Rudolph E., editor / Boundary Problems in Differential Equations / The Univ. of Wisconsin Press, 811 State St., Madison, Wis. / 1960, offset, 324 pp, \$4.00.

This book contains the nineteen papers which were delivered at the Symposium on Boundary Problems in Differential Equations, conducted by the Math. Research Center, U. S. Army, at the Univ. of Wisconsin, April, 1959. The papers discuss differential equations conjoined with boundary conditions the practical ap-

plication of which includes, for example, the flight of a projectile. Among the topics are: "A Numerical Method for Analytic Continuation," "Boundary Value Problems in Thermoelasticity," and "Application of the Theory of Monotonic Operators to Boundary Value Problems." An index is included.

Bellman, Richard / Introduction to Matrix Analysis / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1960, printed, 328 pp, \$10.00.

This book covers three basic fields in the analysis of matrices—symmetric matrices and quadratic forms, matrices and differential equations, and positive matrices and their use in probability theory and mathematical economics. In sixteen chapters, the author discusses the analysis and application of matrix theory in a manner to suit the needs of the professional mathematician or physicist. Four

NEW GLOSSARY OF COMPUTER TERMS

In June we sent to the printer **Computers and Automation's Fifth Edition** (1960) of the:

GLOSSARY OF TERMS IN COMPUTERS AND DATA PROCESSING

96 pages long, this edition contains over 860 computer terms and expressions with their definitions, EXPLAINED so that people new to the computer field can understand them. (Our last edition, October, 1956, contained 490 terms.) This will be an invaluable guide to "understanding your way around" the computer field. Returnable for full refund within 10 days if not satisfactory. Why not take a look at it? See prices below in the coupon.

SPECIAL COMBINATION OFFER:

Each monthly issue of **Computers and Automation** now has 12 additional pages of "News of Computers and Data Processors: ACROSS THE EDITOR'S DESK." Of course, articles, ideas, forum, reference information, surveys, etc., are all there still; and the June issue is the annual edition of "THE COMPUTER DIRECTORY AND BUYER'S GUIDE." Regular subscription rate, U.S.A., one year, \$7.50.

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(Mail this coupon, or a copy of it)
To: **COMPUTERS AND AUTOMATION**, 815 Washington St., R 148, Newtonville 60, Mass.

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☐ Other requests (please explain)

My name and address are *attached*.

appendices cover Linear Equations and Rank, the Quadratic Form of Selberg, A Method of Hermite, and Moments and Quadratic Forms. An index is included.

Karlin, Samuel / Matrix Games, Programming, and Mathematical Economics / Addison-Wesley Pub. Co., Inc., Reading, Mass. / 1960, printed, 433 pp, \$10.75.

This book is the first volume of a study of game theory together with related concepts of mathematical economics. The theory of matrix games is discussed in part one, including the definition of a game, and min-max theory; solutions to some discrete games and solutions to problems are included in the text. The second part, on linear and nonlinear programming and mathematical economics, includes computational methods for linear programming and game theory. Three appendices cover vector spaces and matrices, convex sets and convex functions, and miscellaneous topics. A bibliography and an index are included.

Karlin, Samuel / The Theory of Infinite Games / Addison-Wesley Pub. Co., Inc., Reading, Mass. / 1960, printed, 386 pp, \$10.75.

This book is the second volume of a rigorous presentation of the concepts of game theory. After defining a game and discussing the min-max theorem, the author describes the nature and structure of infinite games. The remainder of the book is devoted to various types of games, including infinite classical games not played over the unit square, games of timing of one action for each player, and poker and general parlor games. Solutions to problems are provided. Three appendices include vector spaces and matrices, convex sets and convex functions, and miscellaneous topics. A bibliography and index are included.

Hawley, George F. / Automating the Manufacturing Process / Reinhold Pub. Corp., 430 Park Ave., New York 22, N.Y. / 1959, printed 147 pp, \$4.95

This book presents in an understandable and interesting way some of the problems involved in designing and engineering machinery for automatic operations such as assembly of components, packaging, and feeding. The roles of the inventor, design engineer, production planner, and engineer are described. In fourteen chapters, the author traces the inventive process, pointing out some of the dangers to watch for.

Postley, John A. / Computers and People: Business Activity in the New World of Data Processing / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1960, printed, 246 pp, \$6.00.

This book, written for the non-technical person who may use computers in busi-

ness, presents a thorough and realistic view of possible applications of data processing. The author discusses the relationship of electronic computers to business activities, and includes information on cost, concepts of operation, problems of transition, practicality, etc. The development of computers is traced; the future is explored. In general, the book succeeds in providing an insight into the use of a computer, and in explaining what can be accomplished with the use of data processing. An index is included.

Kloeffler, Royce Gerald / Industrial Electronics and Control / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1960, printed, 540 pp, \$10.00

This second edition approaches the electronic theory of rectification, amplification, and oscillation through solid state theory. Recent developments, including solid-state thyatrons, cryotrons, and cold cathode vacuum tubes are examined. The college engineering student will find the text a simply written survey of the theory and applications of electronics in industry. The book contains eighteen chapters and an index.

Beer, Stafford / Cybernetics and Management / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1960, printed, 214 pp, \$4.50.

The basic principles of cybernetics, "the science of communication and control," are presented; the aim of the book is to introduce to management the basic principles, the important ideas, and the main terms, with a minimum of mathematics. The parts are titled: Basic Notions; The Logical Theory of Cybernetics; The Biophysical Theory; The Analogue Theory. The book contains a list of references and an index.

LaRochelle, P. J. and R. E. Brescia / Some Probability Aspects of the Aircraft Collision Problem, PB151556 / Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. / 1959, printed, 46 pp, \$1.25.

This paper reports on research which establishes that current air navigation devices can be used to determine aircraft collision hazards, if suitable techniques are employed. The techniques, including coding and analysis of data error distribution, are discussed.

Kac, Mark / Statistical Independence in Probability, Analysis and Number Theory / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1959, printed, 93 pp, \$3.00.

The application of probabilistic ideas outside the field of probability theory is discussed in this book. Stressing the interconnections between different mathematical disciplines, the author, presents information on the normal law, kinetic theory, continued fractions, the distribution of primes, etc.

Wylie, C. R., Jr. / Advanced Engineering Mathematics (second edition) / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1960, printed, 696 pp, \$9.00.

The main objective of this book is to provide an introduction to the branches of mathematics which are of importance to engineers and physicists. Fifteen chapters include clear presentations of the theory of finite differences, determinants and matrices, first order ordinary differential equations, Fourier series, Laplace transforms, vector analysis, theory of complex functions, and conformal mapping. An appendix which covers Graeffe's root-squaring process, is followed by answers to odd-numbered problems and an index.

Fahnestock, James D. / Computers and How They Work / Ziff-Davis Pub. Co., One Park Ave., New York 16, N.Y. / 1960, printed, 228 pp, \$4.95.

The beginner in the field of computers will find this book an excellent introduction to electronic data processing. Easy-to-understand explanations are given for all aspects of the computer—from what they do, to how they do it. A typical chapter, "How Computers Remember," includes a discussion of memory-access, magnetic core properties, buffers, shift registers, recording modes, etc. The book contains an index.

Besserer, C. W., and Hazel C. Besserer / Guide to the Space Age / Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N.Y. / 1959, printed, 320 pp, \$7.95.

The terminology of modern space technology is presented in this book, which aims to standardize the language, and to serve as a lexicon for technical and non-technical people. More than 5,000 definitions are listed alphabetically, including abbreviations and slang expressions.

Kemeny, John G. / A Philosopher Looks at Science / D. Van Nostrand Co., Inc., Princeton, New Jersey / 1959, printed, 273 pp, \$6.50.

The first part of this book discusses the subjects which science presupposes, i.e., language, mathematics, various laws, probability. The author, a mathematician and philosopher, head of the Dept. of Mathematics at Dartmouth College, continues in the second part to probe into scientific logic—induction, for example—and to investigate what constitutes "good explanation" of some scientific principle. The third part of the book is an evocative discussion of cardinal problems in science, including the theory of evolution, metaphysical determinism, free will, and the predictability of human action. The future of science is considered in the final chapter. A bibliography and index are included.

Lurch, E. Norman / Fundamentals of Electronics—An Introduction to Modern Electronics / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1960, printed, 631 pp, \$8.25.

Written specifically for the non-engineer, this book serves as an introduction to the field of electronics, including tubes, transistors, rectifiers, amplifiers, etc., preparing the reader for many specialized areas of study. In twenty-six chapters, the author discusses early theoretical data, then presents the modern concepts. The reader needs little mathematics, but needs some knowledge of d-c and a-c electric circuits and a familiarity with some electrical terms, to understand the material. Two appendices, answers to odd-numbered problems, and an index follow the text.

Modern Trends in Documentation / Pergamon Press, Inc., 122 East 55 St., New York 22, N.Y. / 1959, printed, 103 pp, \$5.00.

Documentation and information retrieval were discussed at a symposium sponsored by the School of Library Science of the Univ. of S. Calif., held in 1958. This volume includes a foreword by the editor, Dr. Martha Boaz, ten papers, a panel discussion, and an index.

Proceedings of an International Symposium on the Theory of Switching, parts I, II / vol. 29 and 30 of the *Annals of the Computation Laboratory of Harvard Univ.* / Harvard University Press, Cambridge 38, Mass. / 1959, printed, 650 pp, \$15.00. (each)

In April, 1957, the Harvard Univ. Computation Laboratory convened an international symposium to enable research workers on switching theory to share ideas and discuss progress. Thirty-nine of the papers which were then presented, are included in these two volumes. The papers were presented in sessions on abstract models, contact networks, magnetic and transistor logic, switching systems and new switches.

The Punched Card Data Processing Annual / Gille Associates, Inc., 956 Maccabees Bldg., Detroit 2, Mich. / 1959 printed, 240 pp, \$15.00.

This book provides a reference guide to applications of punched card equipment, including a survey of applications in use, wiring tips and techniques, and a directory of data processing supplies and services. A Computer Guide section contains information on electronic equipment including diagrams, and, a comparison chart on most commonly used computers. An index follows the text.

Ivall, T. E. / Electronic Computers, Principles and Applications (second edition) / Philosophical Library, Inc., 15 East 40 St., New York, N.Y. / 1960, printed, 263 pp, \$15.00.

A non-mathematical introduction to the theory and application of electronic computers is presented in this book. Twelve of the book's fourteen chapters discuss the circuitry and construction of digital and analogue computers. The last three chapters cover applications of digital computers, recent developments, and a

discussion of the future applications of data processing. An index is included.

Proceedings of the International Assn. for Analog Computation / Presses Academiques Europeennes, chaussee de Charleroi, Bruxelles 6, Belgium / vol. 2, no. 1, Jan., 1960, quarterly, printed, 51 pp, cost?

Contains articles in French, German, and English, on various applications of analog data processing systems, including "A Two-Variable Function Generator," and "Error Analysis of a D-C Integrator." A bibliography and a section on computer news are presented in the three languages.

Linguistic and Engineering Studies in Automatic Language Translation of Scientific Russian into English / University of Washington Press, Seattle 5, Wash. / 1960, printed, 658 pp, \$10.00.

A summary of the problems, planning, procedures and achievements of the first lexicographical research into translation by machine, is presented. The report, in two parts—Linguistic and Engineering Analysis—includes a number of appendices containing machine translation papers, and, a previously unpublished report by W. Ryland Hill. The book includes selected Russian texts and simulated machine translations.

Niemoeller, Ralph K. / "CANNAC," The Computable Alpha-Numeric Name Code / R. K. Niemoeller, 317 N. 11 St., St. Louis 1, Mo. / 1959, offset, 11 pp, cost?

In this publication, a code is described which aims at solving the problem of alphabetical filing by computer. The "CANNAC" system is used to compute numeric identifications; the system is based on surnames, first names and middle initials. Tables which list numeric correspondences for alphabetical data, are included.

Marcus, M. / Basic Theorems in Matrix Theory; National Bureau of Standards, Applied Mathematics Series No. 57, / Supt. of Documents, U. S. Gov't Printing Office, Wash. 25, D. C. / 1960, printed, 27 pp, 15c.

This publication presents a survey of the basic identities and inequalities of matrix theory, and can serve as a reference for research workers and students. Included are results dealing with elementary properties, canonical forms, invariance, congruence, eigenvalues and other topics. References are given, though proofs for theorems are not.

Bulletin du Centre International Provisoire de Calcul / Palazzo degli Uffici, Zona dell'EUR, Rome, Italy / nos. 6-7, Oct., 1959, printed, 72 pp, cost?

This publication of the Provisional International Computation Center in Rome, written in French and in English, presents short reports on conferences, meetings and developments in the computer field. It also contains reports in standard

form describing 21 computer laboratories and centers in Germany, United States, Japan, Canada, Belgium, France, England, etc.

Experiment with Automatically Legible Transfer Forms / Netherlands Postal and Telecommunications Services, publication no. 3, May, 1959 / Netherlands P. and T. Services, 12 Kortenaerkade, The Hague, Netherlands / printed, 1959, 42 pp, cost?

Contains a description of a new input technique for writing checks, in which the public enters numbers once as handwritten figures, and a second time as handwritten dots in certain positions in a grid; this makes it possible to automatically read data produced by the public. The first experiment having been a success, a second and larger experiment is under way by the Netherlands Postal Cheque and Clearing Service. The purpose of this report is to inform computer people of the work being done, in the hope that international cooperation will lead to progress in this phase of computer input.

Pulvari, Charles F. / Research on Barium Titanate and Other Ferroelectric Materials for Use as Information Storage Media, PB 151835 / Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. / 1958, printed, 238 pp, \$3.50.

This report presents practical and theoretical work leading to the production of certain materials including barium titanate. The methods and devices used in the work are described. Applications and uses are pointed out.

Becker, W. M., R. W. Clark and M. S. Hall / Research on Automatic Computation Techniques and Components, PB151834 / Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. / 1958, printed, 176 pp, \$3.00.

Three phases of this research are described, including an engineering study to discover a scheme to serve as the arithmetic unit of a computer, processing methods which would lead to the production of barium titanate with properties suitable for computer use, and phosphor-photoconductor research.

Research Highlights of the National Bureau of Standards, Annual Report, 1959, / Supt. of Documents, U. S. Gov't. Printing Office, Wash. 25, D. C. / 1960, printed, 169 pp, 55c.

This illustrated report furnishes information on the significant developments in the research program of the Bureau, during 1959. A wide range of scientific studies, laboratory experiments and instrumentation developments are covered. The report also includes a summary of the Bureau's Calibration, Testing and Standard Samples program, publication program and cooperative research with industry program.

SURVEY OF RECENT ARTICLES

Moses M. Berlin
Cambridge, Mass.

We publish here a survey of articles related to computers and data processors, and their applications and implications, occurring in certain magazines. We seek to cover at least the following magazines:

Automatic Control
Automation and Automatic
Equipment News (British)
Business Week
Communications of the Association for Computing
Machinery
Control Engineering
Datamation
Electronics
Industrial Research
Instruments and Control
Systems
ISA Journal
Proceedings of the IRE
The Office
Scientific American

The purpose of this type of reference information is to help anybody interested in computers find articles of particular relation to this field in these magazines.

For each article, we publish: the title of the article / the name of the author(s) / the magazine and issue where it appears / the publisher's name and address / two or three sentences telling what the article is about.

Changing from Analog to Digital Programming by Digital Techniques / Marvin L. Stein and Jack Rose / Journal of the Assn. for Computing Machinery, vol. 7, no. 1, Jan., 1960, p 10 / ACM, Mt. Royal & Guilford Aves., Balto. 2, Md.

This paper describes a method for accomplishing the shift from an analog computer to a digital computer, to solve problems set up for the former machine. In particular, a digital computer may be programmed to determine the differential equations which an analog computer will

solve directly; the input to the digital computer is an appropriate description of the setup diagram of the analog computer.

Computer Switching with High-Power Transistors / J. S. Ronne / Electronics, vol. 33, no. 10, Mar. 4, 1960, p 44 / McGraw-Hill Pub. Co., Inc., 330 West 42 St., New York 36, N.Y.

This article discusses methods for selecting the appropriate power transistor and switching circuit in order to obtain the desired switching speed, pulse gain and current-carrying capacity. The three requirements are explained, and information is given on typical characteristics of the transistors.

A Survey of Soviet Work on Automatic Translation / Anthony G. Oettinger / Mechanical Translation, vol. 5, no. 3, Dec., 1958, p 101 / Mechanical Translation, Mass. Inst. of Tech., Rm. 20D-102, Cambridge 39, Mass.

The object of this article is to acquaint English-speaking computer people who are working on translation, with the accomplishments in Russia. A comprehensive bibliography accompanies the article.

The Common Machine Language for Banks / Edith Harwith Goodman / Computing News, vol. 8, no. 4, Feb. 15, 1960, p 167-3 to 167-5 / Computing News, Box 261, Thousand Oaks, Calif.

This article acquaints one with magnetic ink coding techniques which are being used by banks to process checks. The style which is used to represent numbers is described, and some of the problems inherent in automated check handling are discussed.

Input-Output Buffering and Fortran / David E. Ferguson / Journal of the Assn. for computing Machinery, vol. 7, no. 1, Jan., 1960, p 1 / ACM, Mt. Royal & Guilford Aves., Balto. 2, Md.

The first part of this paper is devoted to a general description and evaluation of buffering methods. The second part discusses a method that is being used with Fortran, on an IBM 709 computer. The principles reviewed in the discussion are concerned with magnetic tape, but may apply equally well to any input-output component.

The Nature of Computer Control / George M. Perry / Internal Auditor,

Dec., 1959, p 29 / Internal Auditor, 120 Wall St., New York 5, N.Y.

This article discusses three types of controls which provide for error-free data. They are, logic and accounting control, machine circuitry controls and internal operational controls. Other techniques of control by computer are described.

Control Computers / Instruments & Control Systems, vol. 33, no. 1, Jan., 1960, p 91 / Instruments Pub. Co., 845 Ridge Ave., Pittsburgh 12, Pa.

A state-of-the-art survey is presented giving information on the features of available digital computers, for control purposes and their announced applications.

Business Has Weathered the Computer Crisis / Sheldon F. Hall / The Office, vol. 51, no. 2, Feb., 1960, p 84 / Office Publications, Inc., 232 Madison Ave., New York 16, N.Y.

Automation, in the past seven years has enjoyed a certain measure of success but a large amount of disenchantment on the part of users. This article points out mistakes early computer users made and offers advice on practical application of data processing.

Systems vol. 25, no. 1, Jan.-Feb., 1960 / Systems Magazine, Sperry Rand Corp., 315 Park Ave. South, New York 10, N.Y. / printed, 42 pp, free on request

Contains 18 brief articles describing applications of the Univac computer and other data processing components manufactured by Sperry Rand. One article on the importance of protecting magnetic tapes, and cites the recent Pentagon fire which resulted in the destruction of valuable taped-stored data.

UNCOL—Universal Computer Oriented Language Revisited / T. B. Steel / Datamation, vol. 6, no. 1, Jan.-Feb. 1960, p 18 / F. D. Thompson Publications, Inc., 141 East 44 St., New York 17, N.Y.

This article reviews the development of "compilers" — automatic programming procedures—and discusses the obsolescence which overtakes computers during and after the evolution of a compiler. The author advocates a universal computer-oriented language as an intermediate between problem oriented languages and machine languages. But he does not say how actually to reach it.

NEW PATENTS

RAYMOND R. SKOLNICK

Reg. Patent Agent

Ford Inst. Co., Div. of Sperry Rand Corp.
Long Island City 1, New York

THE following is a compilation of patents pertaining to computers and associated equipment from the "Official Gazette of the United States Patent Office," dates of issue as indicated. Each entry consists of: patent number / inventor(s) / assignee / invention. Printed copies of patents may be obtained from the U.S. Commissioner of Patents, Washington 25, D.C., at a cost of 25 cents each.

Feb. 2, 1960 (Cont'd)

2,923,470 / Robert M. Beck, Inglewood, Joseph A. Beck, Jr., Balboa Island, and Glenn E. Hagen and Cecil R. Russell, Manhattan Beach, and Charles R. Williams, Palos Verdes Estates, Calif. / Northrop Corp., Hawthorne, Calif. / A digital differential analyzer.

2,923,471 / Eugene L. Treman, Whittier, and Walter Hochwald, Gardena, Calif. / North American Aviation, Inc., Calif. / A binary-to-decimal converter and adder.

2,923,472 / Gordon Earle Whitney, Derby, Colo. / I.B.M. Corp., New York, N.Y. / An arithmetic unit using magnetic core counters.

2,923,473 / Joachim E. Schulze, Oberfrohna, near Karl-Marx-Stadt, Germany / VEB Buchungsmaschinenwerk Karl-Marx-Stadt, Karl-Marx-Stadt, Germany / A digital multiplier apparatus.

2,923,474 / John V. Blankenbaker, Los Angeles, Calif. / Hughes Aircraft Co., a corp. of Del. / Multiple input binary-coded decimal adders and subtractors.

2,923,475 / Raymond W. Ketchledge, Whippany, N.J. / Bell Telephone Lab., Inc., New York, N.Y. / A signal comparison system.

2,923,476 / Raymond W. Ketchledge, Whippany, N.J. / Bell Telephone Lab., Inc., New York, N.Y. / A signal comparison system.

2,923,477 / William H. Newell, Mount Vernon, N.Y. / Sperry Rand Corp., a corp. of Del. / A method and apparatus for solving simultaneous equations.

2,923,817 / Cravens L. Wanlass, Whittier, Calif. / North American Aviation, Inc., Calif. / A logical gating system.

2,923,818 / Robert E. Wilson, Moorestown, and William E. Woods, Haddonfield, N.J. / Radio Corp. of America, a corp. of Del. / A gate forming circuit.

2,923,836 / Richard K. Richards, Poughkeepsie, and Thomas R. Garrity, Wappingers Falls, N.Y. / I.B.M. Corp., New York, N.Y. / A bistable transistor circuit.

2,923,920 / Clyde J. Fitch, Endicott, N.Y. / I.B.M. Corp., New York, N.Y. / An information storage device.

2,923,922 / John A. Blickensderfer, Mountain View, Calif. / General Electric Co., New York, N.Y. / A drum indexing system.

2,923,923 / Samuel K. Raker, Washington, D.C. / I.B.M. Corp., New York, N.Y. / A biased magnetic storage system.

Feb. 9, 1960: 2,924,383 / Eric Weiss, Los Angeles, Calif. / — / Circuitry for multiplication and division.

2,924,384 / Grady T. Porter, Bartlesville, Okla. / Phillips Petroleum Co., a corp. of Del. / An electrical computer for solving simultaneous equations.

2,924,386 / James E. Brook, Hackensack, N.J. / Bendix Aviation Corp., Teterboro, N.J. / An electrical algebraic computing apparatus.

2,924,669 / Lothar M. Schmidt, Glendale, and Harold L. Schwartz, Los Angeles, Calif. / Librascope, Inc., Glendale, Calif. / An endless tape memory system.

Feb. 16, 1960: 2,925,219 / David S. Nee, Palo Alto, Calif. / Marshant Research, Inc., a corp. of Calif. / A binary number modifier.

2,925,500 / Albert J. Meyerhoff, Wynnewood, Pa. / Burroughs Corp., Detroit, Mich. / A balanced logical magnetic circuit.

2,925,501 / Charles R. De Wesse, James W. Lacy, and Roger R. Webster, Dallas, Tex. / Texas Instruments, Inc., Dallas, Tex. / A discriminator circuit.

2,925,587 / Ragnar Thorensen, Los Angeles, William R. Arsenaault, Santa Monica, and Biagio F. Ambrosio, Los Angeles, Calif. / U.S.A. as represented by the Sec. of Commerce / A magnetic drum memory for electronic computers.

2,925,588 / Ivan H. Sublette, Haddonfield, N.J., and Lowell S. Bensky, Levittown, Pa. / R.C.A., a corp. of Del. / A memory reading system.

2,925,589 / Edward J. Schmitt, Haddonfield, N.J. / R.C.A., a corp. of Del. / An information handling system.

Feb. 23, 1960: 2,926,337 / Luis A. F. Rivas, Levittown, Pa. / R.C.A., a corp. of Del. / A data selection device.

2,926,338 / Lowell S. Bensky, Levittown, Pa., and David L. Nettleton and Arthur D. Beard, Haddonfield, N.J. /

R.C.A., a corp. of Del. / A method of and system for storing data magnetically.

2,926,339 / Noah H. Kramer and Harry W. Mathers, Johnson City, N.Y. / I.B.M. Corp., New York, N.Y. / A logical switching circuit utilizing cores of magnetic material.

2,926,342 / John L. Rogers, Morristown, N.J. / Bell Telephone Lab., Inc., New York, N.Y. / A magnetic memory device utilizing a magnetic element having a substantially rectangular hysteresis loop.

March 1, 1960: 2,926,730 / Orville V. Greunke, Westport, Conn. / Sperry Rand Corp., a corp. of Del. / A combined electronic data storage and control system.

2,926,850 / Richard K. Richards, Poughkeepsie, N.Y. / I.B.M. Corp., New York, N.Y. / A binary adder-subtractor.

2,926,851 / Donald A. Weir and Joseph Rice, London, Eng. / International Standard Electric Corp., New York, N.Y. / A binary adder-subtractor.

2,927,306 / Esmond P. G. Wright and Joseph Rice, London, Eng. / International Standard Electric Corp., New York, N.Y. / Computing systems for handling intelligence in various ways.

2,927,312 / Gerard J. R. Piel, Paris, Fr. / Societe d'Electronique et d'Automatisme, Courbevoie, Fr. / An analog-to-digital converter system.

2,927,313 / Arthur H. Dickinson, Greenwich, Conn. / I.B.M. Corp., New York, N.Y. / An electronic data processing machine.

March 8, 1960: 2,927,730 / Jack K. Midgough, Metuchen, and William R. Young, Jr., Summit, N.J. / Bell Telephone Laboratories, Inc., New York, N.Y. / An automatic data reader for analyzing data in the form of coded signals recorded on a multitrack magnetic tape.

2,927,732 / Robert M. Rinder and Robert M. Walsh, Berkeley, Eugene P. Hamilton, Richmond, Charles M. Hill and Oliver J. Cotey, Oakland, and George B. Greene, Berkeley, Calif. and William B. Bennett, Albuquerque, N. Mex. / Marchant Research, Inc., a corp. of Calif. / An electronic computer.

2,927,733 / Carl M. Campbell, Jr., Bryn Mawr, Pa. / Burroughs Corp., Detroit, Mich. / A gating circuit.

2,927,734 / Arthur W. Vance, Cranbury, N.J. / R.C.A., a corp. of Del. / A computing system for an electronic resolver.

- 2,928,033 / Wilton R. Abbott, Palo Alto, Calif. / North American Aviation, Inc. / A digital comparator.
- 2,928,073 / Evon C. Geanias, Vestal, N.Y. / I.B.M. Corp., New York, N.Y. / A data sensing and handling apparatus.
- 2,928,076 / George B. Greene, Berkeley, Calif. / Marchant Research, Inc., a corp. of Calif. / An electronic computer.
- 2,928,077 / Gerhard Dirks, Frankfurt am Main, Germany / — / An apparatus for sorting of signals recorded on a magnetisable signal carrier.
- 2,928,080 / Isaac L. Auerbach, Phila., Pa. / Burroughs Corp., Detroit, Mich. / A static memory system.
- March 15, 1960: 2,928,596 / John C. Sims, Jr., Spring House, and Herbert Frazer Welsh, Phila., Pa. / Sperry Rand Corp., a corp. of Del. / A system for reading information from a card having indicia thereon.
- 2,928,598 / Eugene V. Heitlinger, Franklin Park, Ill. / Comptometer Corp., a corp. of Ill. / A significant digit indicating mechanism for a split accumulator mechanism.
- 2,928,600 / Howard M. Fleming, Jr., Basking Ridge, N.J. / Monroe Calculating Machine Co., Orange, N.J. / A binary to decimal radix conversion apparatus.
- 2,928,601 / Daniel L. Curtis, Manhattan Beach, Calif. / Hughes Aircraft Co., a corp. of Del. / A binary coded decimal arithmetic unit for electronically performing the arithmetic operation of addition or subtraction upon electrical signals.
- 2,928,602 / James A. Quinn, North Massapequa, N.Y., Sperry Rand Corp., a corp. of Del. / An electro-mechanical analog differentiating device.
- 2,928,896 / Gerhard Dirks, Frankfurt am Main, Germany / — / A high speed printing device.
- 2,928,936 / Heinz Bock, Hamburg, Germany / North American Philips Co.,

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Inc., New York, N.Y. / A self-oscillating additive mixer circuit.

2,928,938 / Frank P. Forbath, North Hollywood, and Jay M. Hansen, Santa Monica, Calif. / Hughes Aircraft Co., Culver City, Calif. / A computer register.

2,928,983 / Frederic C. Williams, Timperley, and Tom Kilburn, Davyhulme, Manchester, Eng. / I.B.M. Corp., New York, N.Y. / An electrical information storage apparatus.

March 22, 1960: 2,929,556 / Joseph K. Hawkins, Manhattan Beach, and Robert C. Jackson, Redondo Beach, Calif. / Alwac International, Bahamas, B.W.I. / A data converter and punch card transducer for digital computers.

March 29, 1960: 2,930,530 / Frank E. Saxby, Eastcote, and Ronald Pritchard, Ickenham, Eng. / The National Cash Register Co., Dayton, Ohio / An electronic digital serial binary adder.

ADVERTISING INDEX

Following is the index of advertisements. Each item contains: Name and address of the advertiser / page number where the advertisement appears / name of agency if any.

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill. / Page 23 / Reincke, Meyer & Finn

Dialight Corp., 60 Stewart Ave., Brooklyn 37, N.Y. / Page 30 / H. J. Gold Co.

International Business Machines Corp., Data Processing Div., 112 East Post Rd., White Plains, N.Y. / Pages 16, 17 / Benton & Bowles, Inc.

Minneapolis-Honeywell, Datamatic Div., Wellesley Hills 81, Mass. / Pages 19, 20, 31 / Batten, Barton, Durstine & Osborn, Inc.

National Cash Register Co., Dayton 9, Ohio / Page 32 / McCann-Erickson, Inc.

Philco Corp., Government & Industrial Group, Computer Div., 3900 Welsh Rd., Willow Grove, Pa. / Page 3 / Maxwell Associates, Inc.

The Ramo-Wooldridge Laboratories, A Div. of Thompson Ramo Wooldridge, Inc., 8433 Fallbrook Ave., Canoga Park, Calif. / Page 13 / The McCarty Co.

Space Technology Laboratories, Inc., P. O. Box 95004A, Los Angeles 45, Calif. / Page 5 / Gaynor & Ducas, Inc.

Technical Operations, Inc., 3600 M St., N.W., Washington 7, D. C. / Page 21 / Dawson MacLeod & Stivers

Wheeler-Fairchild, Inc., 610 So. Arroyo Parkway, Pasadena, Calif. / Page 22 / —

ONLY HONEYWELL GUARANTEES ITS SYSTEMS WON'T DAMAGE YOUR TAPES!

NOW...HONEYWELL EDP SYSTEMS AIR-CUSHION MAGNETIC TAPE TO PROTECT VALUABLE RECORDS

Honeywell electronic data processing scientists have developed the world's most reliable tape drive mechanism. It virtually eliminates the common causes of tape damage which can shut down the equipment for costly minutes or hours. This new technique is so reliable that Honeywell is the only computer manufacturer that guarantees its Systems will not break or damage your tapes during processing. If they do, tapes will be replaced without charge.

NO PINCH ROLLERS — ANYWHERE. Only Honeywell 800 and 400 high-speed Systems transport magnetic tape by air throughout the processing cycle. Vacuum capstans take the place of old-fashioned pinch rollers, dramatically reducing wear and tear, flaking and scratching. The recording surface is touched only by the recording head and only when information is read or recorded. Since nearly every read-

write error can be traced to tape surface damage, it is clear why Honeywell tape drives are intriguing managements in all parts of the business world.

ADD ORTHOTRONIC CONTROL — AND MAKE SURE. Added to this advanced technique of vacuum transport is Honeywell's exclusive Orthotronic Control, which insures uninterrupted accuracy during processing. Using Orthotronic Control, Honeywell Systems can re-create lost or damaged data instantaneously — without human aid, without reprocessing. Errors can be detected and corrected *automatically* in 1/20th of a second. Where other systems would stop and blink signals for human help, Honeywell 800 and Honeywell 400 will simply do what needs to be done and keep humming right along at top speed.

ELIMINATE UNPRODUCTIVE MACHINE TIME. This self-correcting ability plus the protection inherent

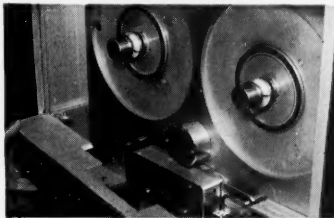
in airborne tape combine to boost your profit potential on any data processing application. These Honeywell scientific advances help eliminate machine downtime, which methods men know can often cancel the economic gains of electronic data processing.

INVESTIGATE HONEYWELL 800 AND 400 SYSTEMS. Greater reliability in data recording is but one of the several major factors that multiply the cost advantages to users of Honeywell EDP Systems. If your company is now considering the move to electronics, we respectfully suggest you put Honeywell Systems at the top of your list for investigation. Our applications engineers will be glad to discuss your individual requirements.

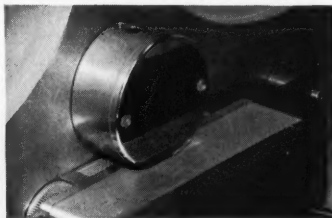
For more information, get in touch with your nearest Honeywell office. Or write Minneapolis-Honeywell, Datamatic Division, Wellesley Hills 81, Massachusetts; or Honeywell Controls Ltd., Toronto 17, Ontario.

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WHY HONEYWELL RECORDING TECHNIQUES ARE FASTER, MORE RELIABLE



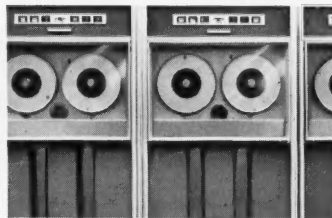
Vacuum capstans propel tape gently and precisely throughout processing cycle, removing danger of damage by pinch rollers.



Recording head alone touches recording surface of magnetic tape, reads information with tape moving forward or backwards.



Tape changes can be made in less than 25 seconds. Changes on other data processing systems often require several minutes.

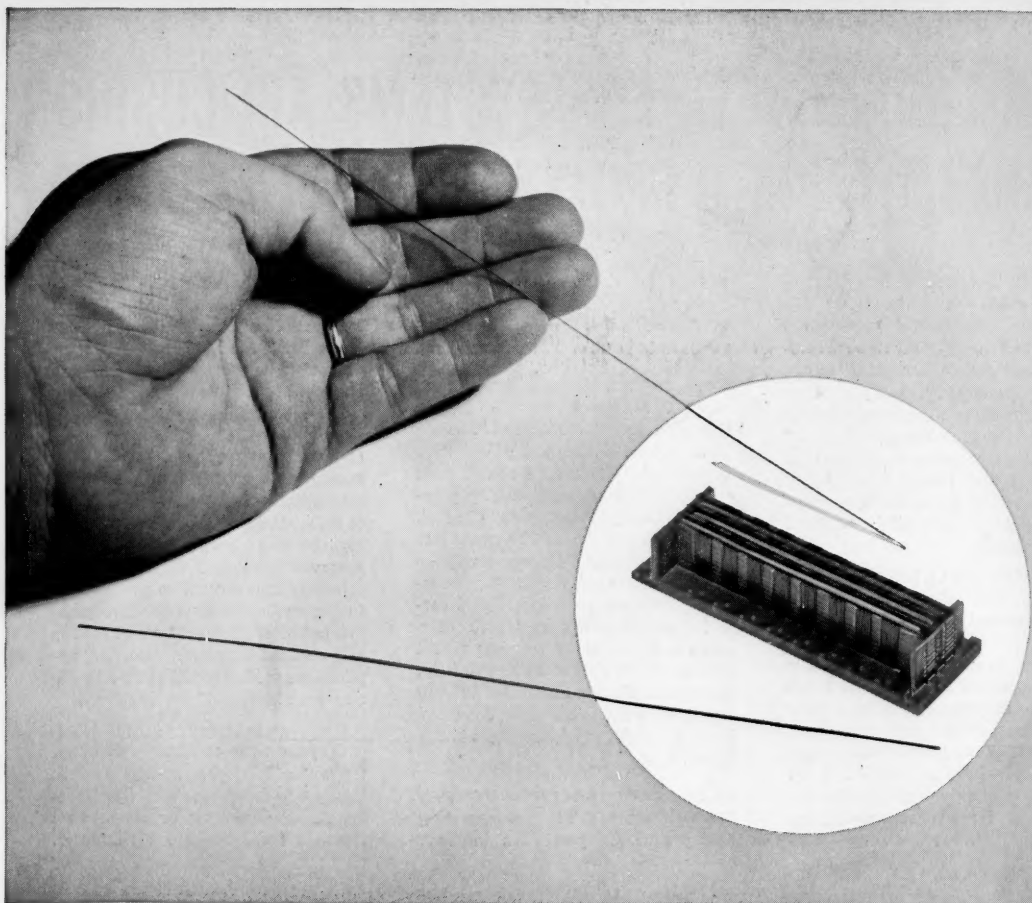


Information is read or recorded with tape moving 120 inches per second, a transfer rate of 96,000 decimal digits per second.

Honeywell



Electronic Data Processing



National's "BIT WIRE" AMAZING NEW DEVICE FOR MEMORY AND LOGIC

"BIT WIRE" represents a recent NCR breakthrough in magnetic data storage and logic devices. Pictured above, in a linear memory employment, "Bit Wire" is a conductive wire electrodeposited with magnetic material. It offers the advantages of reliability, flexibility, and greater switching speeds... economic and compact component fabrication. In addition, this amazing wire is useful over a wide range of temperatures. Memory and logic are but a few of the applications to which it is ideally suited. Perhaps you can qualify for a rewarding career with this unique device... or with other challenging NCR projects...

CHEMISTRY: Plastics and polymers, micro-encapsulation (of liquids or reactive solids),

photochromic materials (compounds which can be alternated between two distinct color states), magnetic coatings.

DATA PROCESSING: Computer theory and component development, programming studies, high-speed non-mechanical printing and multi-copy methods, direct character recognition, systems design.

SOLID STATE PHYSICS: Electro, chemical, and vacuum deposited magnetic films ferrites and ferro-magnetics, advanced magnetic tape studies, electroluminescence-photoconductor investigations.

ADVANCED ENGINEERING DEVELOPMENT: High-speed switching circuits, random access memory systems, circuit design (conventional, printed, etched), advanced electron

beam type storage. The location of the new NCR Research and Development Center is progressive, energetic Dayton, Ohio. Facilities are extensive—a veritable "city within a city."

COMPLETE INFORMATION is yours by sending your résumé to Mr. T. F. Wade, Technical Placement Section F5-3, The National Cash Register Company, Dayton 9, Ohio. All correspondence will be kept strictly confidential.

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